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THE BOOK OF THE MANGO

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PREFACE.

THE mango is a fruit that for hundreds of years has been grown in India. In ancient literature there are frequent references to it, and we find a mango tree among the sculptures on the stupa of Bharhut, which dates from 100 B. C.

The mango is now grown in most tropical and subtropical regions of the world. A certain amount of literature regarding its cultivation is to be found in the Journals and Bulletins of Agricultural Departments. We have consulted all such available material, and in this book offer occasional extracts and précis from these writings.

The bulk of the work here presented is, however, original, being the results of observations and experiments made since 1908 in the Ganeshkhind Botanical Gardens, Kirkee, and in various parts of the Bombay Presidency.

The purely botanical part of these results has been omitted, and what is now presented will, we hope, be useful to growers or sellers of mangoes.

W. BURNS.
S. H. PRAYAG.

TABLE OF CONTENTS

THE MANGO.

CHAPTER I.

The Home of the Mango.

(Mango = Sanskrit, Amra ; Marathi, Hindustani and Singalese, Amba ; Persian, Amb or Amba ; Bengali, Am ; Tamil, Mangas Marum ; Kanarese, Manv ; Burmese, That-yat ; Chinese, Mang-kwo ; Javanese, Palam ; Arabian, Maghzak.)

There is no doubt that the mango was known to the dwellers of India at a remote period of history. The Sanskrit words for the mango are आम्र "Amra," चूत "Chuta," रसाल "Rasala" and सहकार "Sahakara." In अमरकोश "Amarkosh" written by अमरसिंह "Amarsinha" who lived in the Buddhistic times, the synonymous words for the mango are given in the following *shlok* (couplet) :—

॥आम्रश्चूतो रसालो ऽसौ सहकारो ऽतिसौरभ: ॥

Amra, Chuta, Rasala, Sahakara, Atisourabha.

Blochmann[1] gives the following extract :—

"About three hundred years ago Abul-Fazl wrote in his 'Ain-i-Akbari' that there was a considerable number of cultivated varieties of mango in India and especially mentioned the splendid orchard owned by Hussein who lived between the reigns of Akbar and Jehangir and who was a physician and afterwards Governor of Agra, Behar, etc., attached to the court of prince Salem, where Kairnah mangoes had a conspicuous place at Delhi."

Abul-Fazl also described a large number of cultivated races. Babar speaks of the excellence of the fruits in 1526.

References by foreigners.

The Chinese Hionam-Thsang[2] who visited India between 632 and 645 A.D. seems to be the earliest traveller to refer to the mango. By travellers[3] from the west it is first mentioned under the name of "Ambag" by Ebn Hankal who probably lived between 902 and 968 A.D. Later travellers who mention the mango are Friar Jordanus Catalani, who described it in his Mirabilis Descripta, written about

(1) Blochmann's translation of the Ain-i-Akbari, quoted from P. C. De's "Treatise on the Mango."

(2) Pickering C., Chron. History of Plants, 1879, p. 237. Reproduced from Wester's Mango, p. 12.

(3) Wester, The Mango, p. 12.

1330 A.D. Ebn Batuta,[1] visiting India in 1325 to 1349, speaks of the mango as a product of the Indian Archipelago. Nicolo Conti between 1419 and 1444 noted the mango in Malabar and Ludovici De Varthema 1503 to 1508 A.D. in Calicut. It has been mentioned by Pirard who travelled in India in the early part of the seventeenth century.

Geographical distribution.

The mango is a tropical fruit and, as such, grows in all tropical and sub-tropical climates. It thrives well in many parts of India, though the sea-coast appears to be more congenial to it. Its dissemination outside India has been surprisingly slow. The following tabular form[2] shows its distribution in the different parts of the world and the dates of introduction as far as known :—

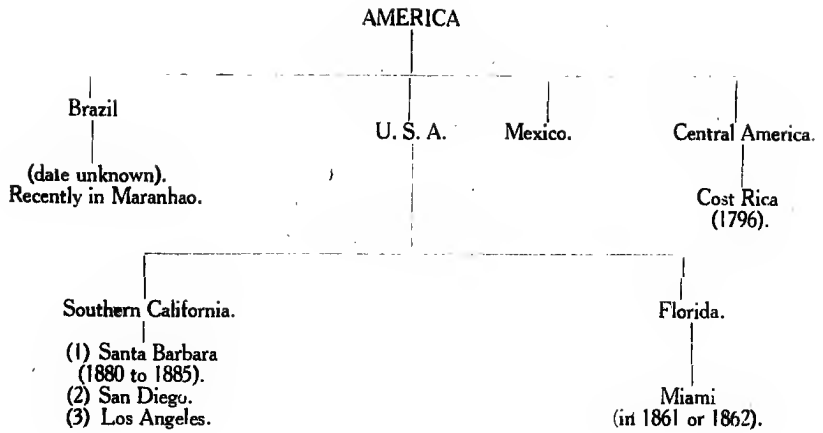
ASIA.

Turkey in Asia	Arabia	China
Yemen (latter part of 18th century).		Cochin China (date unknown).

Indian Ocean	.. Islands of Reunion, Madagascar, Bourbon (middle of 18th century), Mauritius and Seychelles.
Africa	.. Somali land 1331. Mosambique, Egypt, Cairo and Livingstonia (last three recently).
Atlantic Ocean	.. Madeira, Canaries (19th century), Azores, 1865.
Pacific Ocean	.. Hawaii (1865), Fiji Islands.
East Indies	.. Philippine Islands (after 1600), Moluccas (1665).
West Indies	.. Barbados, Jamaica, Santa Domingo, Cuba.
Europe	.. Southern Italy (1905), Portugal (Iberian Peninsula).
	England (Hampton Court in 1690) (fruited in Kew in 1808).
Australia	.. New South Wales, Queensland (about 50 years ago).

(1) Wester, The Mango, p. 12.

(2) From information supplied on the works of Wester, Watts, etc.



Soils.

The mango seems adaptable to a wider range of soils than many fruit trees, provided the soil is sufficiently deep and well drained. In the Bombay Presidency, although mango trees are seen in every village, yet there are undoubtedly certain classes of soils that influence the yield and excellence of the fruit. Woodrow[1] states that fruit of the highest quality may be produced on a loamy soil three feet in depth containing 5—10 per cent. of lime and enough peroxide of iron to give the soil a reddish tinge. He mentions that an excellent mango tope is found on the banks of the Mula river near Ganeshkhind in alluvial loamy soil to a depth of five feet. He also refers to another plantation of 5,000 trees near Khed Shivapur, a few miles south of Poona, situated on a soil of five feet of dark brown loam, nine feet of marl, two feet of gravel and three feet of very porous murum (a disintegrated form of trap rock).

From our observations, it appears that the red soils of Dharwar derived primarily from hæmatitic quartzite and containing very few pieces of rock and the red laterite soils of Belgaum, Ratnagiri and Goa are pre-eminently suited to the mango. The mango does not thrive on soils with much hard rock, shale or pure sand. Mr. P. C. De[2] says: "Argillaceous and loamy soils having sufficient depth are pre-eminently suited to the mango." Maries[3] writes, there are fine mango trees yielding good crops on *kankar* or soils having a large proportion of lime nodules at Gwalior. Miranda[4] states with regard to Goa that in sandy tracts the fruit is decidedly of inferior quality, watery

(1) The Mango, p. 10. (2) Treatise on Mango, p. 13. (3) Woodrow, The Mango.
(4) Miranda, Poona Agre. Coll. Mag., Vol. VI, No. 1, p. 33.

and insipid. The best crop in point of quality, size, colour and taste is obtained from the trees grown on the slopes of the hills. Generally trees standing on a loose, porous but rich substratum return regular normal yields.

Drieberg, then Secretary of the Agricultural Society, Peredeniya, Ceylon, writing on 17th August 1914, with regard to mango trials, stated that in laterite and red laterite and gravelly red clay loam, gravelly loam and a mixture of clay and gravel, the growth of the trees was vigorous, while in sandy loam and clay the growth was slow and stunted although the trees were healthy. The Officiating Secretary of the Port of Calcutta stated that out of seventy-two mango trees sent for trials, only four survived, and says that this failure was due to their being planted in exposed positions in sand with but a sprinkling of earth at their roots (letter of 18th September 1914). "The mango is not exacting in its soil requirements, demanding only that it should be deep rich and well drained, conditions which are required by most fruit trees. Though it requires a liberal amount of moisture, it is not tolerant of wet unaerated soil."(1) In the black cotton soils of the Southern Maratha Country, grafted mangoes grow but do not thrive so well as in the other favourable soils mentioned. The most astonishingly rapid growth that we have seen, has been in soil of the Kopargaon Taluka of the Ahmednagar District. The soil had been fallowed for some time and is underlaid by murum. The trees had made a growth of ten feet in two years.

In judging soils, the sub-soil has to be taken into account. The mango will not thrive with a hard rocky subsoil or a subsoil of marl. The roots of the full-grown tree penetrate deeply, and if they encounter such strata the tree suffers and may die.

CLIMATE.

Temperature.

The mango will not thrive out of doors where there is a certainty of frost. Young trees may be completely killed by frost, and older trees have their younger parts destroyed. It can be easily understood that yearly frost would severely stunt a tree and might prevent its flowering. On February 2, 1911, a frost occurred at Poona with disastrous effects to the flowers, all of which were blackened and killed. In 1912, a consignment of grafted mango plants was sent from Ganeshkhind Botanical Gardens Poona, to the Director General

(1) Bulletin 12 of Hawaii Agricultural Experiment Station,

of Agriculture, Cairo, Egypt. These were planted in heavy loam immediately on arrival. In June 1913 he states that " in winter they (the plants) were covered with coarse canvas but notwithstanding this twenty were killed by frost. Imported plants of mango seem to suffer more from cold than those raised from seeds in the country."

The experience of the Superintendent, Saharanpur Gardens, regarding frost effects was as follows[1]:—

" The main point of interest during 1911, was the effect of the severe frost experienced on the 9th of February. The intensity of this frost would vary according to the situation but judging from the records in other situations, there must have been eight degrees of frost in the particular place where the mango plants, now reported on, were growing. It is usual in this part of India to cover all young plants of mangoes during the winter, but the weather being very mild during the latter end of January and first week of February, and as severe frosts were previously unknown here after that time, the plants were uncovered, with disastrous results. Of grafted plants of two years old, the following were killed :—

Carabo, Dauna, Nayab, Dofasli, Dilshad, Badaya, Gola, Bombay, Jait, Jallibunda, Khirsapat, Kuar Bhog, Langra, Patna No. 1, Lahi, Mashuq, Langra Allahabadi, Langra Hajipur, Moradabad, Amin, Mombasa, Punia, Phoot Gola, Durbangha, Singra, Sandurea, Strawberry, Sharifa, Tamancha, Zarda.

The following varieties were not affected by the frost :—

Amir Gola, Baramasi, Bharbhujan, Calcutta, Garden, Ennurea, Fayirwala, Gola, Hathijhul, Kachmahua, Karania round, Kararia, Krishna Bhog, Langra Saoni, Langra Hardoi, Malda, Multani, Nayab, Sufaida No. 1, Sunder-shah.

The above lists, although of some value in determining hardiness, must, however, not be reckoned as conclusive. It was particularly noted that the stronger and healthier the plant the better it stood the test. The weak plants invariably suffered the most, irrespective of the variety.

The effect of frost on seedling plants of different varieties may be taken as more conclusive. These were all healthy plants, planted in February 1914, the seedlings being then about 1½ years old.

(1) Annual Report of Saharanpur Botanical Gardens, March 31, 1914.

The following were killed outright :—

Alphonse, Arbuthnot, Bhurdas, Bombay yellow, Calcutta Garden, Chapta Faizan, Fajri long, Gola, Kala, Karania round, Sharbati brown, Singapuri, Sunahra, Zafran, Sepia, Machli, Gopal Dhopa, Zardalu, Hasina.

Those unaffected were :—Dr. King, Kachmahua, Khajya, Krishna-Bhog, Langra Hardoi, Madras, Mombasa, Najibabadi, Amin, Naspati, Nucka, Salinunda, Sundrea, Surkha, Stalkart, Romani. The last, by the way, flowered when 3½ years old from the seed.

With regard to the *maximum* temperature that the mango will stand there are no exact data available. In the hot parts of the Bombay Presidency, for example, Sholapur with a maximum of 108°, the tree thrives. In Sind with a maximum of 118°, it also grows well.

Higgins[1] states :—" The mango is distinctly a tropical tree and must be protected from frost or even chilly temperatures if it is expected to do its best. For this reason in part, the lower elevations of these islands are better suited to it than the higher lands. Since the Hawaiian climate is scarcely tropical, yet up to several hundred feet the trees produce fair crops and even at quite high altitudes grow well but without bearing freely."

Woodrow [2] says :—" The mango tree grows freely in all tropical or sub-tropical climates with a mean shade temperature of from 75° F. to 80° F. with a normal minimum above freezing point and abundant moisture either in the atmosphere or at the roots."

Moisture.—All over the Bombay Presidency there are found well-grown trees which get no water except that which falls in the monsoon. Some of these trees may have been irrigated till they reach bearing age but many in the rice lands of the Konkan and the jungles of the Ghats have received no such attention. In the two latter locations the annual rainfall varies from 80 to 200 inches per year. In the drier parts of the Presidency it is found necessary to irrigate up till the bearing age. It is also found necessary to irrigate in districts of heavy rainfall where the soil is exceedingly porous and where the plantations are on the slopes of hills as at Ratnagiri.

Woodrow[2] says :—" A rainfall from 50 to 100 inches yearly, and falling chiefly from June till the end of September, is suitable but the rainfall may be much less if irrigation be available or the trees be planted

(1) The Mango in Hawaii. Bulletin 12, p. 8, of the Hawaii Agri. Exp. St., 1906.
(2) The Mango, p. 9.

near tanks so that the roots may find water by extending downward as occurs in Sind."

Mr. P. C. De[1] says : " Passing from the driest plains of Rajputana where rainfall averages under 10 inches, we find the same in the Central Provinces and Bihar from 30 to 50 inches ; while in Bengal proper and in the lower regions of the Himalayas, from 50 to 100 inches. Again, in Assam and Darjeeling and the Western Ghats it ranges above 100 inches. From the above calculations and practical observations, it may be fairly concluded that the Provinces receiving varied rainfall of from 30 to 100 inches annually, are generally adapted for its cultivation, although with more or less advantage."

Wester[2] says : " A yearly rainfall of 1250 to 2500 mm. (37½ to 75 inches) falling mainly from June to the end of September is most suitable for the mango but where irrigation is available it will succeed with less rainfall than this."

Higgins[3] says : " As to the moisture requirements the mango is better suited to an irrigated region than to one of natural rainfall because of the bad effects of rain at flowering time, and indeed throughout the entire life of the tree, where the mango blight (*Colletotrichum* species) is known, and further, because it is a distinct advantage to be able to apply water when it is most needed and withhold it when it will do harm."

Collins[4] says : " Rains at the time of flowering seem to be specially injurious. It has been suggested by Mr. Hartless and others that the moist weather interferes with pollination. If this is accomplished by insects the damp weather may easily affect their operations."

In the Bombay Presidency it has been our experience that rain or fog at the flowering time spoils the flowers and prevents the setting of fruits. This is especially the case in the Thana District, one of the sea-coast Collectorates, penetrated by creeks and having a considerable amount of hilly jungle. Rain in January and February is, however, rare. Fog is more common and its damage is considerable. Whether this damage is direct or partly through Jassid insects remains to be proved.

[5] " In most of the other important mango districts the precipitation is heavier than at Saharanpur. It is sometimes as great as 100 inches

(1) Treatise on Mango, p. 12.

(2) The Mango, p. 39.

(3) The Mango in Hawaii, p. 8.

(4) The Mango in Porto Rico, p. 13.

(5) Popenoe, Cuba Magazine, Vol. IV, No. 8, April 1913, p. 357.

per annum at Darbhanga and Maldah, yet it does not occur during the ripening season and coming at other times of the year, it is of benefit rather than detriment. It is generally believed throughout India that damp weather at the time of flowering is one of the commonest causes of crop failures. The mango flower possesses one pollen bearing stamen and the structure of the former is such that this as well as the stigma, which must receive the pollen, are exposed to the weather and the slightest dampness in the air above the degree of humidity, washes away the pollen and prevents fertilization. This seems to be one of the principal reasons why the mango fails to bear heavily in excessively moist climates."

Mr. P. C. De[1] says : " Excessive dew is apt to wash away the pollen grains depriving the pistils of the power of fertilization."

We must. in truthfulness, add that we have no experimental data in India concerning the relation of mango pollination to weather.

The time of flowering in the Bombay Presidency is affected by climatic conditions. In the southern parts of the Bombay Presidency on the coast, the flowering and fruiting are earlier by a month than near Bombay City and again Bombay is earlier than Poona, which lies on the plateau above the ghats, with a comparatively small rainfall and a drier climate.

Collins[2] says : " It may be considered as proved that the mango will be prolific only in regions subjected to a considerable dry season. On the moist north side of Porto Rico the trees grow luxuriantly but they are not nearly so prolific nor is the fruit of such good quality as on the dry south side and in the very dry region about Yauco and at Cabo Rojo, the fruit seemed at its best while its abundance was attested by the fact that fine fruit was selling as low as 12 for a cent."

[3] " In Guatemala and Mexico the mango was found at its best only in regions where severe dry seasons prevailed. It was also found to be the case in Jamaica. All agree that the mango fruits but sparingly in moist localities and is much more prolific in dry seasons."

Mr. Macmillan in a letter of July 16th, 1914, says : " Indian mangoes generally do not appear to be suited to our moist climate (Ceylon)."

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(1) Treatise on Mango, p. 21.
(2) The Mango in Porto Rico, p. 30.
(3) Do. p. 13.

F. W. Popenoe[1] says : " Lower Bengal is noted as a hot humid tropical region where even the most delicate plants, such as, for instance the Amherstia, can be grown to perfection. To the mind of the average Northern horticulturist, it is in just such regions that the mango should thrive, but quite the contrary is the case, and it requires only one glance at any of the mango topes about Calcutta, to show that the trees are far from healthy, and not adapted to such a region. Their growth is scraggy, their foliage thin and of an unhealthy colour and the fruit does not ripen well. A sharp contrast to these conditions are the trees at Saharanpur which are vigorous and stocky, the foliage abundant and of that rich green colour which speaks volumes. It is this comparatively dry atmosphere coupled with the extreme heat that produces mangoes that have made Saharanpur famous. At the same time the relative humidity never goes as low as it does in some parts of the S.W. United States and conditions are by no means those of a desert country."

From what has been said above, it will be seen that the tropical climate with a distinct dry season at the time of flowering is congenial and suited to the mango and that a continously moist climate is not congenial. In the Bombay Presidency, it can be said that the hot climate of the tropical sea-shore, with just the right amount of moisture from the proximity of the ocean, is well adapted to the mango. Vigorous growing, early fruiting plants are produced in this area and the fruits are of excellent quality.

The dry climate of the Deccan and the Southern Maratha Country is also well suited to the mango, though the flowering time is retarded by about a month.

Altitude.

Macmillan[2] says : " The mango tree grows from sea-level to above 4,000 feet or more but is scarcely fruitful at elevations over 2,000 feet in Ceylon. A hot and rather dry climate suits it best."

Mr. P. C. De[3] says : " In the celestial regions of the Himalaya above the altitude of 4,000 feet the mango can seldom grow or thrive under ordinary conditions."

Watt[4] says : " The home of the tree in the Himalayas is from 1,000 to 2,000 feet.

(1) Cuba Magazine, Vol. IV, p. 356.
(2) Handbook of Tropical Gardening and Planting, Ed. II., p. 169.
(3) Treatise on Mango, p. 11.
(4) Dictionary of Economic Products, Vol. V, p. 148.

CHAPTER II.

Propagation of the Mango.

In nature the mango tree is propagated by the seed contained in its fruit. In horticulture, the mango is usually propagated by grafting scions of a desirable variety on stocks of some inferior race. The question naturally arises, "What are the advantages of grafting?" The usual answer given is "You cannot be sure that a seedling tree will bear the same quality of fruits as its parent." There appears to be little experimental evidence for this statement. The following may be quoted: "[1]At the Saharanpur Botanical Gardens some experiments were made during the year 1881 and 1893 from which it was determined that seedlings from grafted varieties were fairly certain to produce fruit of good quality. However, the experiments were made upon one race or type of mango only, the Bombay, and were not carried out on a very extensive scale; they could not really be considered as producing any definite results. An experimenter in Queensland at about the same time reported having grown seedlings of the Alphonse variety to the fourth generation from a grafted tree, all of them coming exactly true to type and indistinguishable from the grafted parent."

Firminger[2] says: "Mr. J. Homphray has likewise in his garden a grafted tree received from Botanic Garden of the Mazagaon mango, stones from the fruit of which he planted, and one or two trees raised therefrom produced fruit exactly alike and fully equal in every respect to the fruit of the parent tree. In a conversation I had with Mr. P. Homphray many years after he made the above communication he told me that he had since sown the seeds of other kinds but not met with the same results from them. The seedling did not yield fruit equal to that of the parent tree. The Java kind, however, always came true as a seedling."

Collins[3] says: "The ease and rapidity with which mangoes can be propagated by means of seed are decided advantages, but the results are very uncertain, and very few of the really desirable varieties can be maintained by this method." There are a few good varieties in different parts of the world, the seedlings of which appear to produce fruits identical with the parent. Mr. A. M. D'Cruz, a leading horticulturist of Bombay, in his letter dated 27th July 1911, says: "At a place called Jambordi, near the Dahanu Station on the Bombay,

(1) Cuba Magazine, January 1913, Vol. IV, No. 5, p. 221.
(2) Quoting Report of the Botanical Gardens, N. W. F. P., 1854.
(3) The Mango in Porto Rico.

Baroda and Central India Railway Line, there are two mango trees bearing quite a distinct species of mango. A friend of the owner had two seeds brought down to Mahim, and sown there without any special attention. Both germinated and grew up to be good vigorous trees and produced the very same kinds of fruits as in Jambordi. The latest information received from the oldest mali of Goregaon is that there is a tree of about 6 years old raised from the Alphonse mango seed. It bears fruits quite as good as the grafted ones. I missed seeing it when it was in fruit."

At this point, it is imperative to say something regarding the mono-embryonic and polyembryonic types of mango, as this has a close connection with the question at issue, namely, why should we graft? On its practical side, the following is the important fact. In mono-embryonic mangoes, the embryo is the product of the female sexual cell contained in the ovary and the male sexual cell brought in the pollen grain. The embryo, therefore, will be of a pure character if the pollen is from the same tree or a tree of the same variety as that bearing the ovum, but of a hybrid character, if the pollen has come from a tree of a different variety. If the embryo is therefore a hybrid, it may be expected that its fruits will differ in some way from those of its female parent, and most markedly so, when the male parent is of very different type. In the case of a polyembryonic mango one embryo (often absent) may be produced by fertilisation, but all the rest are vegetative growths of the ovule tissue of the female parent. There is therefore no admixture of foreign blood into them, and they *must* come true to type and produce the same kind of fruits as their parent. Wester[1] says: "In Florida the observation has been made that the seedling types, all being polyembryonic, transmit their characters to their progeny in a remarkable degree, that is, come true to seed. Of course, variation exists, but the main characters of the type are well reproduced. This feature of reproduction of type, of the inferior seedling varieties, has also been noted in Jamaica, contrary to the habit of the imported grafted varieties from India, whose progeny is very variable. The types grown in Philippines, popularly but incorrectly called varieties, are also polyembryonic and thus, as is well known, reproduce their racial characteristics to a remarkable degree. In juxtaposition to this character of the polyembryonic types (to reproduce themselves true to seed) the progeny of the monoembryonic varieties of India seem to be variable and there appears to be little doubt that the species may be divided into two great divisions,

(1) The Mango, p. 47.

one containing the polyembryonic mangoes, whose progeny retain the racial characters of the parents, the other monoembryonic varieties from India whose progeny is variable."

Until further exact experiments have been carried out in India, it is impossible to say to what extent any variety comes true from seed. That hybrid fruits can be produced has been proved by us and it is quite likely that these occur in nature. As long as doubt prevails vegetative propagation is the only method of ensuring an adult plant that will give fruits of the desired variety. We shall now discuss some of the methods of propagating the mango vegetatively.

Propagation by cuttings.—We have so far been entirely unsuccessful in propagating the plant by cuttings. Attempts to do so were made in 1913-14 and 1914-15. Cuttings of Pairi and Alphonse varieties were planted in sandy soil and kept in glass frames for over two months but no roots appeared nor was any callus formed. Some of the cuttings produced shoots, doubtless on account of the stored food material. The cuttings were made from wood of a year old. In all 100 cuttings were tried, but with no success in the production of roots. The cuttings were put in June 1913 and in March and October 1914 and April 1915.

In the Bureau of Plant Industry, Bulletin 46, page 13, mention is made of mango cuttings producing callus invariably. The root though produced is slow to form and is usually of a single fibre, of so small and brittle a nature that the rooted cutting is difficult of transplantation.

At the present moment no reason can be given for the failure of the mango to respond to this method of propagation.

Propagation by layering.—For this operation, select a healthy vigorous growing branch of ripened wood, that will bear being bent down to the earth without breaking, cut the branch half through with a sharp knife just above one of the leaf buds, towards its extremity and then pass the knife upwards so as to slit the branch longitudinally for two inches. The slit should be kept open by inserting a small piece of wood, and the branch weighted with a stone (Fig. 10). We made 24 layers on September 9th, 1912, of Pairi variety of which 7 produced roots. Of these, two showed very small roots on December 18th, 1912, and the rest on April 5th, 1913. These are the dates of examination. The roots had been formed earlier. This proved that the mango will root when layered and that layering may be used as a means of propagation alternative to grafting. It takes a long time,

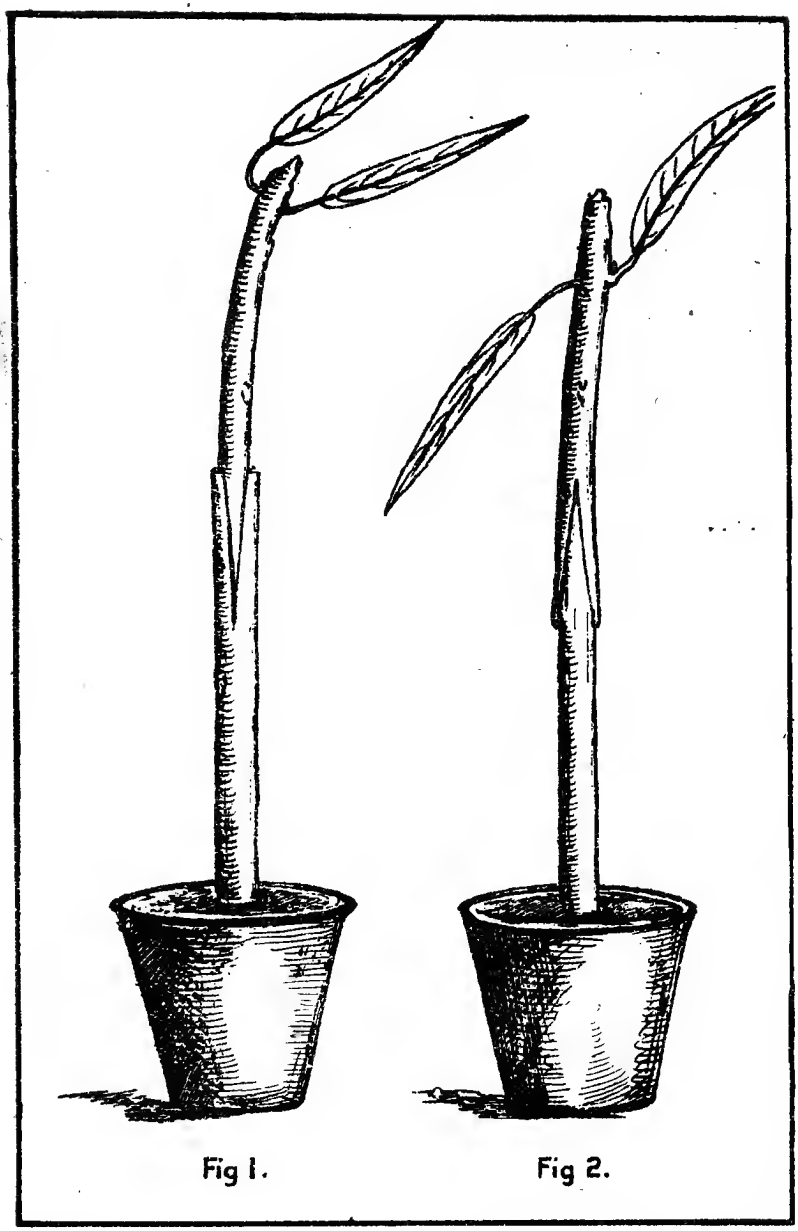


Fig 1. Wedge-graft.
" 2. Saddle-graft (with Scion detached from the parent plant.)

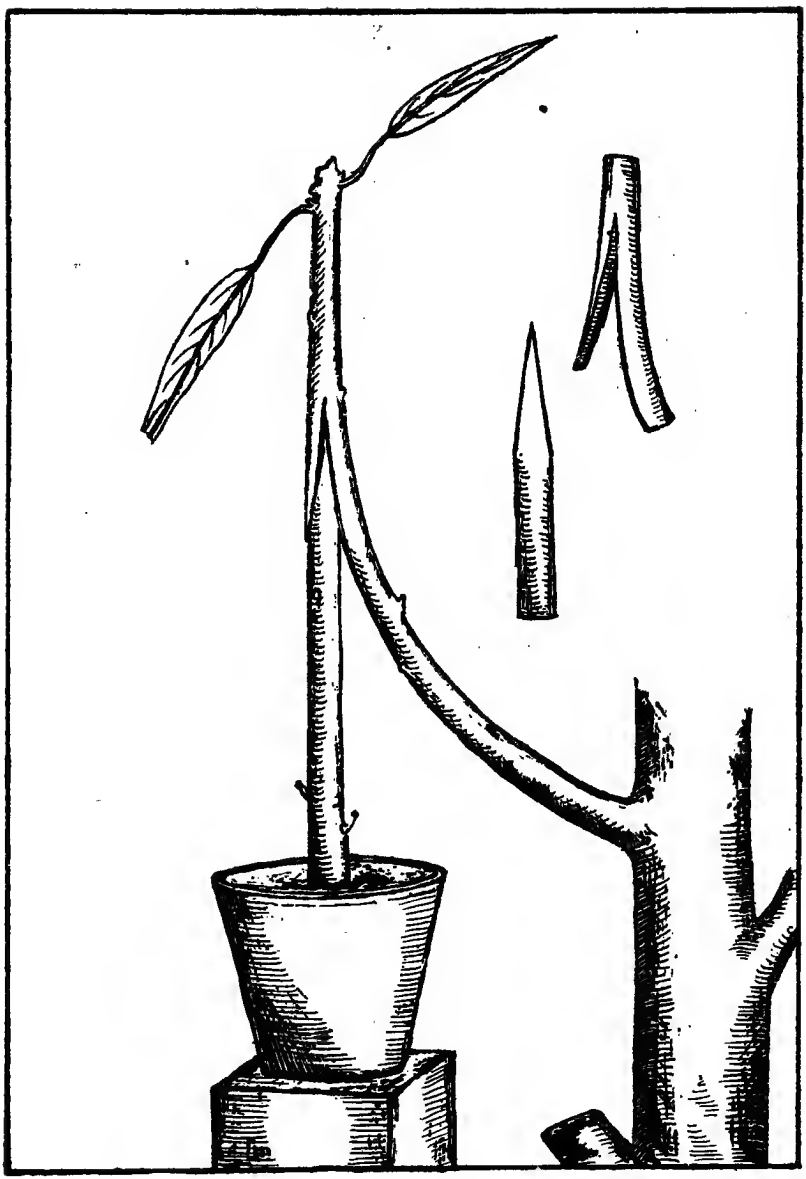


Fig 3.

Saddle-graft with Scion not detached from the parent plant.

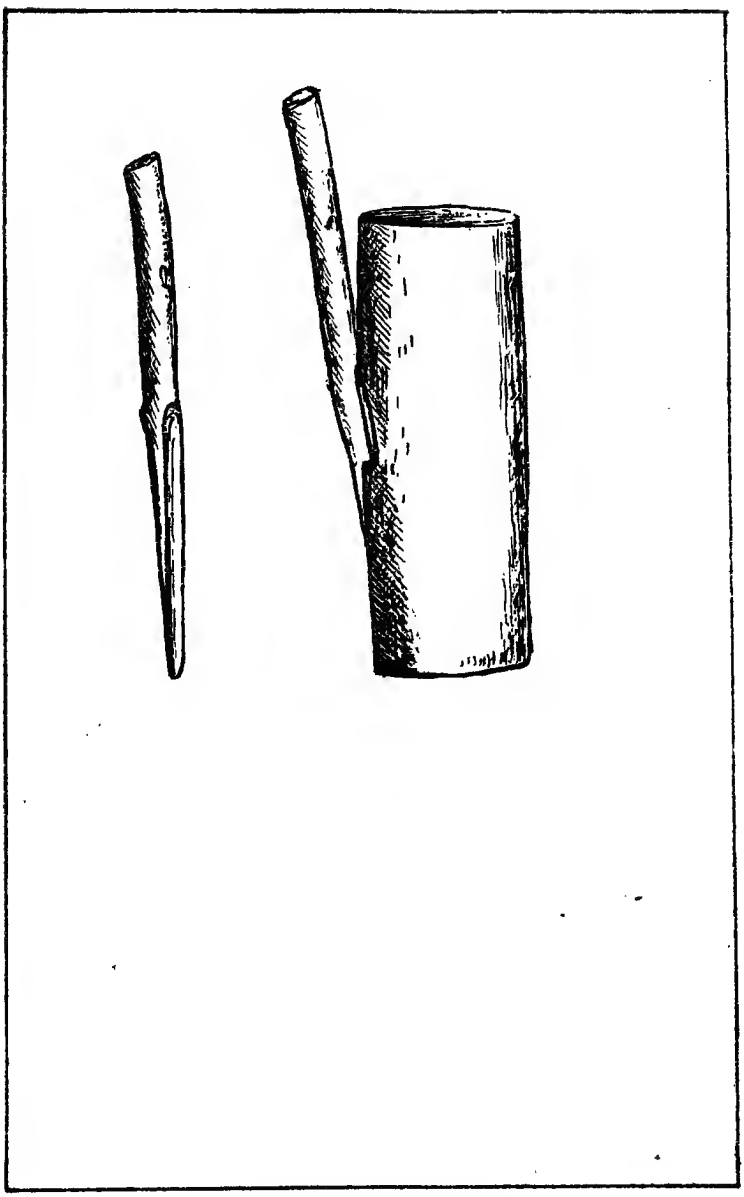


Fig 4. *Side-graft.*

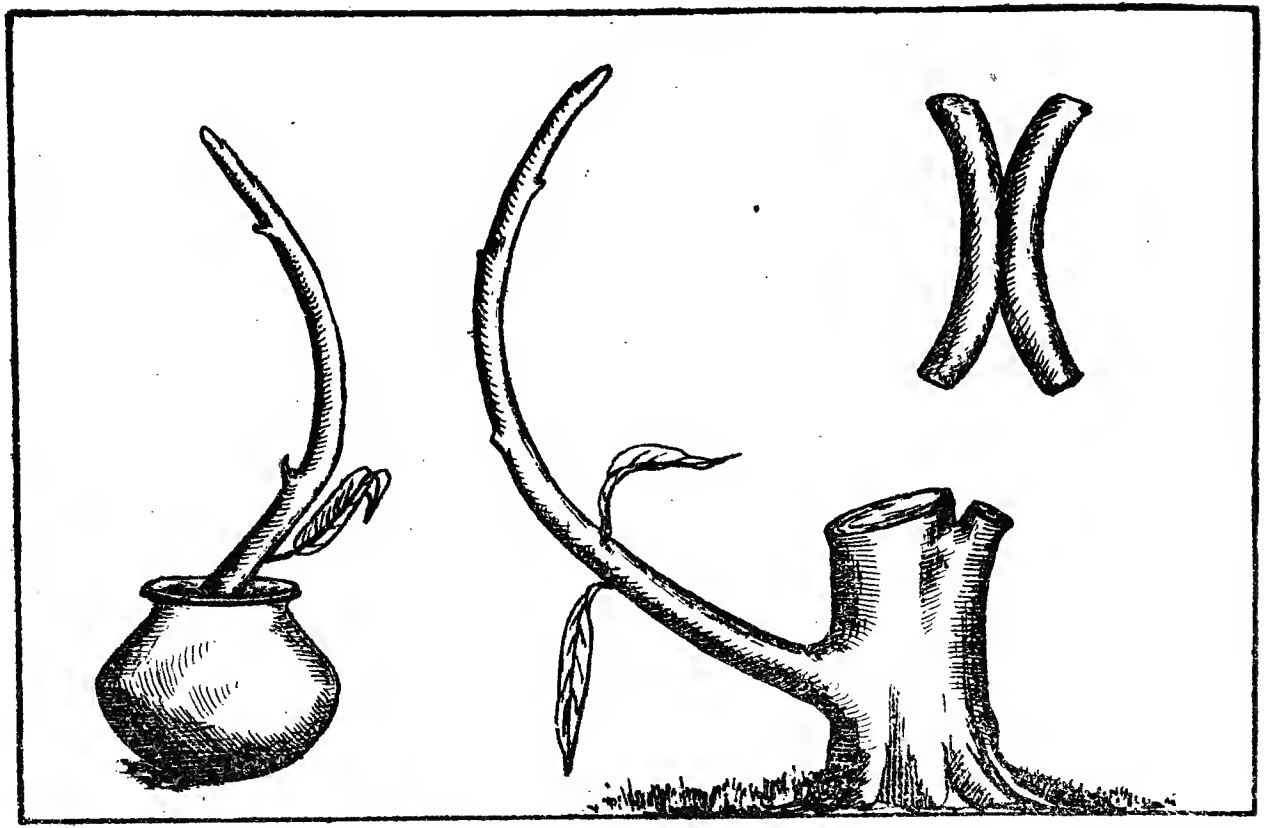


Fig 5. *Enarch-graft.*

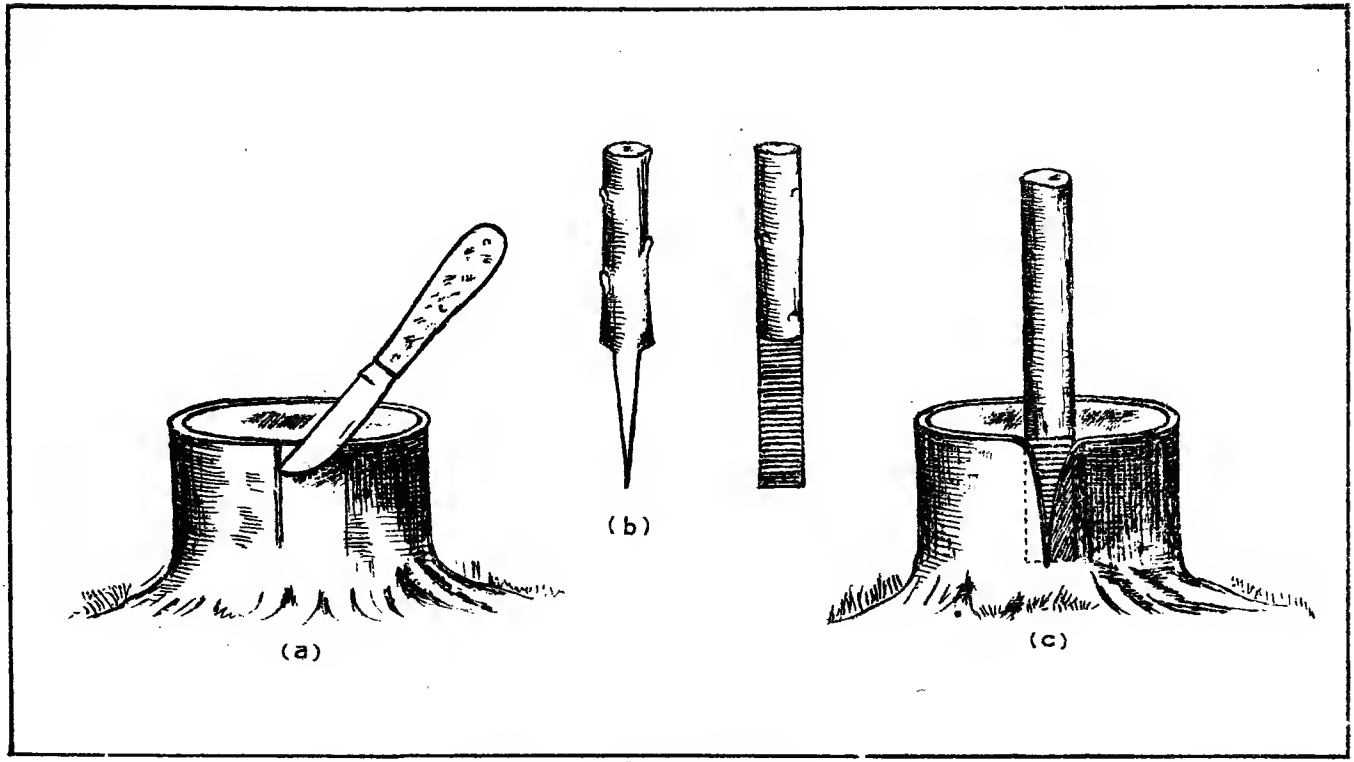


Fig 6. *Crown-graft.*
(a) *Nature of incision in the stock.*
(b) *Scion ready for insertion.*
(c) *Crown-graft after insertion of the Scion.*

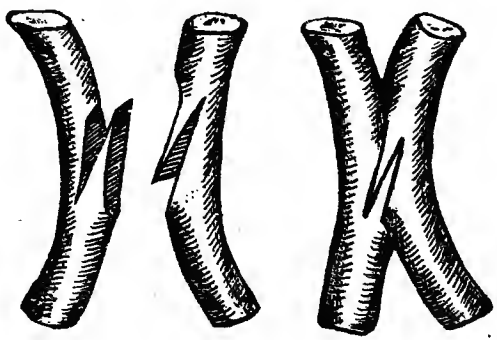


Fig 7.

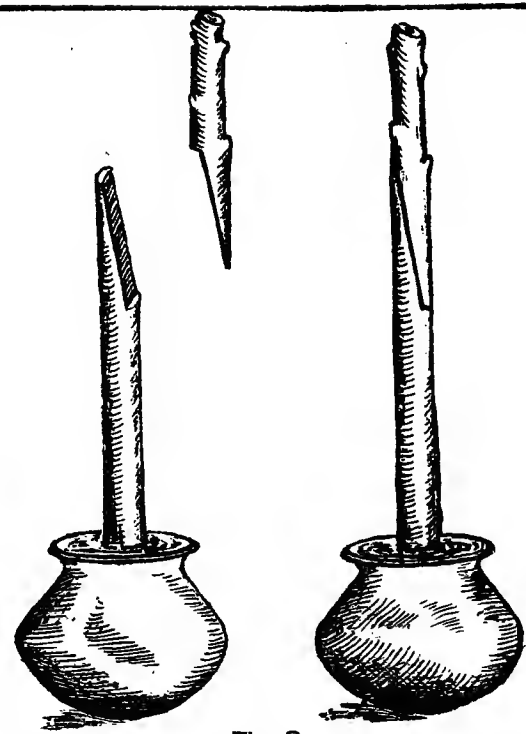
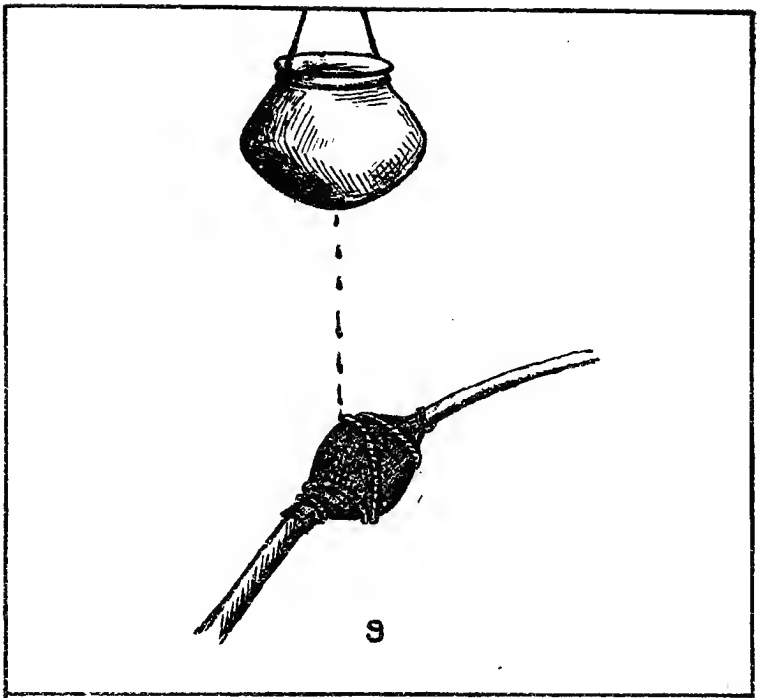


Fig 8.

Fig 7. *Tongue-graft.*

Fig 8. *Whip-graft.*



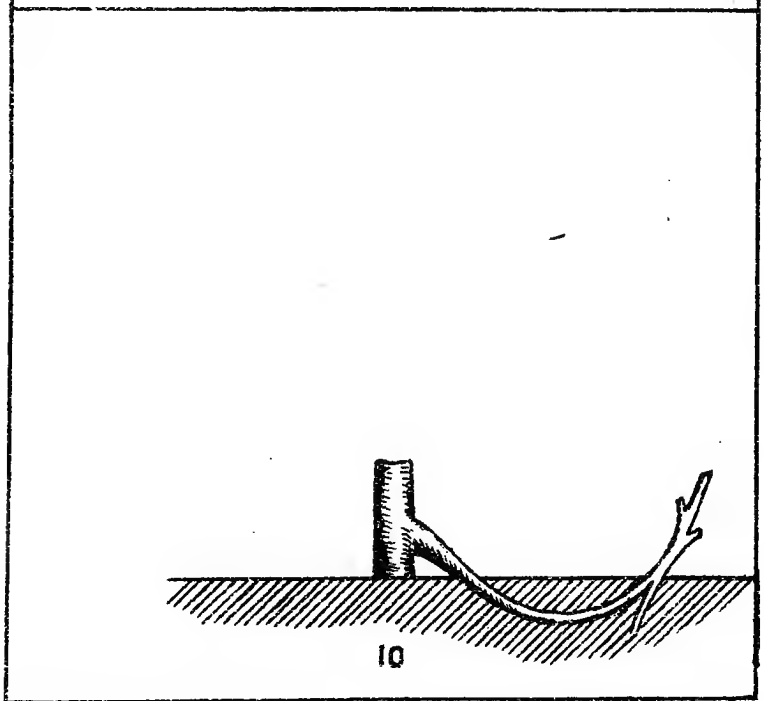


Fig 9. *Gootee.*

Fig 10. *Layering.*

however, to produce roots thus. Success depends on the selection of good and healthy branches for layering. On October 7th, 1913, 25 layerings of Pairi were done. On March 19th, 1914, 7 of these showed very small roots developing from all over the lower surface of the branch and not from the wood. On May 30th, 1914, these 7 were detached from the tree. The layers of both years were in pots till September 30th, 1914, when four were planted in the ground in Ganeshkhind Botanical Garden. None of these have as yet fruited. Of the layers made in 1912 and 1913 two produced flowers on February 5th, 1914, but failed to fruit. These flowers were the first growth made by the terminal buds of the layered branches. This confirms the idea, that the nature of the bud is determined early, and any stimulus causing it to develop will reveal its pre-destined character (whether flowering or vegetative). Layering is referred to by Collins[1] and Higgins.[2]

At present, layering as a substitute for grafting cannot be recommended for the following reasons :—

(1) The percentage of success has not been considerable.

(2) The roots are slow in forming.

(3) The after-growth and fruiting of the layers is very slow.

Propagation by Gootee (Marcotte).—The method consists in removing a ring of bark from a healthy and vigorous growing branch to a length of about 2 inches and surrounding it either with earth (clay and cowdung mixed together in equal proportion) or moss, and taking care to keep it continuously moist. (See Fig. 9.)

Six gootees were made on 11th August 1914 on a country tree. Observations were made on February 25th, 1915. Roots had been produced in 3 gootees only. One of the rooted gootees was detached on February 27th, 1915. It had plenty of roots. It was transplanted into a pot, but did not survive. The other two were detached on June 30th, 1915, and transplanted in the ground. They have not yet flowered.

This method is mentioned by Collins and Higgins but with no data of experiments.

Propagation by grafting.—Grafting is the art of joining the cut surface of the branch of one tree with a similar surface on the stem of another tree, in conditions which cause the cut surfaces to unite permanently. The branch so joined is called the scion and the stem

(1) The Mango in Porto Rico, p. 30.

(2) The Mango in Hawaii, p. 10.

of which it is grafted is called the stock. The actual joining takes place at a soft region just below the bark called the cambium.

The first point to be considered is the preparation of stock plants on which to graft. In this connection, it is to be noted that mango "stones". (seeds) germinate readily when fresh, but soon lose their vitality. On June 30th, 1915, stones were removed from a number of mangoes taken off the tree only a day or two previously. The variety was Shahabuddin and the seeds were all from one tree in the Ganeshkhind Botanical Garden. The following table shows the germination :—

Date of sowing.	No. of stones.	No. germinated.	Percentage of germination.
30th June 1915 ..	50	41	82
22nd July 1915 ..	20	16	80
26th July 1915 ..	25	20	80
7th August 1915 ..	25	12	48
9th September 1915 ..	25	3	12

Higgins[1] reports that 43·5 per cent. of seeds varying from 31 to 41 days old, have produced good plants. He does not mention the varieties used. It may be said, therefore, that it is possible to get a fair germination for a month after the extraction of the seed from the fruit but that germination capacity rapidly decreases afterwards.

Assuming that the stocks are required in pots, the next question is : "Shall we plant the seeds in pots at once or plant in soil and transplant the seedlings into pots?" In soil the plants are as a rule more vigorous and larger. In Ganeshkhind Botanical Gardens on July 26th, 1911, seeds from one country tree were sown, 225 in soil and 250 in pots. After a year the average height of those in the field was 20 inches and 13 inches in the pots.

In continuation of the above line of enquiry, seedlings raised in the ground were in 1912-13 and 1913-14, transplanted into pots, some intact, others with only root-pruning, and others with both root and stem pruned. A great number of plants died. The percentage of success in the most favourable case was 67·5. The conclusions drawn were, that mango seedlings of one year old stand transplanting badly, and that pruning the roots decreases the number of survivals.

(1) The Mango in Hawaii, p. 10.

Woodrow[1] recommends the germination of seeds on a hard surface to prevent the descent of the tap root ; the seed being covered with 4 inch leaf mould. When the first growth has become firm the seedlings, he says, may be transplanted into pots. Wester[2] recommends the sowing of seeds in the soil when pots are not available and subsequent transplanting of the seedlings into pots. He states that the roots are brittle and need careful handling. It is desirable, however, to grow seedlings in pots from the start so as to avoid a check to the growth at the time of transplanting.

Plants in pots very quickly exhaust the plant food contained in the limited amount of soil surrounding their roots. Hence to get strong seedlings it is necessary to add some quick-acting fertiliser Wester[2] recommends the following solution :—

Nitrate of soda	.. ..	Grams ..	275
High Grade Sulphate of Potash	50 per cent.	Do. ..	125
High Grade Acid Phosphate ..	16 per cent.	Do. ..	350
Water	.. ..	Liters ..	100

The following table shows the growth made by seedlings of mango manured with 1 ounce of Sodium Nitrate at a time per plant. The manure was given on May 25th, July 2nd, October 5th, and December 26th, 1911 :—

	No.	Height 25th May 1911 before manuring.	Height on 26th July 1911.	Height on 12th October 1911.	Height on 26th December 1911.	Increase.
		Inches.	Inches.	Inches.	Inches.	Inches.
Manured.	1	18	19·1	22	32	14
	2	15	16	20	This plant was used for budding.	
	3	14	15·2	22·5	29	15
	4	12	12·2	*13·5	*13	1
Not manured.	5	9·5	10	10	12·5	3
	6	10	10·6	12	14	4
	7	14	14·1	16·5	19	5

* Vegetative growth much spoiled by insects.

In two of the manured cases, Nos. 1 and 3, the increase was enormous while in all the controls the increase was very moderate.

(1) The Mango, p. 15. (2) The Mango.

Care should be taken to see that the constituents are completely dissolved and the solution should be stirred as the watering proceeds.

To economise watering, the following procedure has been found useful. Trenches should be dug deep enough for the brim of the pots standing in them to come on a level with the surface. The pots should be placed in position and dry leaves heaped into the trench so as to just cover them. The pots must be lifted once in two months to prevent the tap root entering the soil through the hole in the base of the pot and anchoring the plant there. Plants so kept can be watered at intervals of a week and should be in moderate sunshine. Insects must be looked for and spraying done accordingly. (See Chapter on Insect Pests.)

The next question is, "At what age of the stock should it be grafted?" On this point there is great difference of opinion and practice. There are those who advocate grafting on a very young seedling. Wester[1] says: "The seedling with seed attached thereto, when it is about 15 to 20 cms. high and three weeks old, is carefully lifted with a small ball of earth. The roots, with the earth intact, are then wrapped up in a little grass and the young seedling plants tied to the tender branch of the tree required to be enarched from, care being taken that the young seedling trees and the branch to be grafted should be pointing in the same direction and be of the same age, *i.e.*, both seedling and the graft should be of that year's growth. When grafted, the union should be covered with grafting clay to exclude the air. The roots of the seedling suspended as above described when grafted, must be kept moist by watering either by hand or with a garden syringe in case there is not sufficient rain. The process of grafting should be commenced in the beginning of rainy season, as soon as the young mango seedlings are procurable. The plants should be ready for cutting, *i.e.*, the grafts should have taken well within a month. The grafts should be partially severed at first and completely severed afterwards, but I have succeeded in cutting them as soon as thirteen days after grafting."

Higgins[2] recommends grafting when the stocks are about 6 months old. He states that if allowed to remain too long in pots the roots become cramped and may never recover from the effects.

Collins[3] quoting an article in the *Sugar Journal and Tropical Cultivator*, says that the seedlings are usually fit for grafting in ten

(1) Page 32 quoting L. A. in "Cultural Industries for Queensland, 1883, p. 125."
(2) The Mango in Hawaii, p. 13.
(3) The Mango in Porto Rico, p. 15.

months but if not well grown should be older, and that two-year-old seedlings are very successfully enarched. The stem of the seedling, he says, should be as thick as a man's smallest finger near the root.

In the Ganeshkhind Botanical Garden in the year 1914, two-months-old seedlings with their seed and a lump of soil were removed from the field. The earth and seed was covered with moss and tied in a sacking. Ten such seedlings were grafted on October 28th, 1914, by enarch, on a Pairi tree. The scions were of the same age. Five succeeded and these were later transplanted into the field and are doing well.

The seedlings usually employed by the nurserymen in Western India are two to three years old. In the case of Ratnagiri grafts the scions are much thicker than the stocks and the scion usually becomes top-heavy and makes a poor growth. It is no uncommon thing in Ratnagiri to graft one huge scion on two small stocks.

The arguments advanced in favour of big grafted plants are that they fruit earlier, and are stronger and more durable than the grafts done on younger stocks, but evidence is entirely lacking.

Woodrow[1] says : " The age of the stock in enarching need not be a definite quantity. Stocks of three weeks old and also three years old have been very successfully used as far as union is concerned but as the root of the tree suffers from confinement in a pot, it is advisable to retain the cramped condition as short a time as possible. Seeds planted in June and July produce fine strong plants for stocks by the end of November which may be grafted, during the two succeeding months and be kept in shade during the hot season, will be ready to plant out during July following. By this course vigorous trees are produced which start into growth freely and in due season bear a crop worth attention. A large old graft that has been several years in a pot may yield a few mangoes a year or two earlier than the freely grown tree but a few mangoes do not pay the cost of protection from birds, etc., and the root that was cramped in a pot will probably yield to the first strong breeze that strikes the tree."

It cannot be said at present how far the system of grafting on green stocks will be profitable since the people are induced to buy large grafts. It is also not known as to how the small grafts withstand transit but it can safely be said that we can use $1\frac{1}{2}$ to $2\frac{1}{2}$ years old stocks provided we take care of the stocks by proper transference

(1) The Mango, p. 17.

of these to other pots without disturbing the roots and without allowing the roots to get pot-bound. Care should also be taken to see that, in grafting, the scion should be of equal thickness with the stock.

Influence of Stock on Scion.—There is very little that can be said regarding this, as very few trials have been made either in India or elsewhere. In the mango, the scion appears to have a preponderating influence and reproduces its own type, no matter on what stock. Different stocks may induce different degrees of vegetative vigour in the scion, but here again nothing definite can be said. It may, however, be safely stated that vigorous growing seedlings should be used as stocks. The position of the scion on the stock and the age of the stock *do* influence the vigour of the vegetative growth of the scion and the age at which it flowers. In August 1914, in Ganeshkhind Botanical Gardens, a well grown Shahabuddin tree was used as stock and five branches from grafted plants in pots were transferred to it by grafting. The scions were grafted on to the end of well-ripened branches. In January 1915, two of the scions bore inflorescences but did not develop fruits.

Also in August 1914, one branch of a Borsha grafted plant in a pot was transferred to a country plant and this bore two well developed fruits in May 1915.

In both the above cases the pot plants from which the scions were taken produced no inflorescence, although branches similar to the scions were purposely left to see how they would behave.

In Bassein Garden, a country tree of about 39 years old was heavily cut back on March 6th, 1912. Many new shoots sprang up from the stumps and on these shoots were grafted scions of Alphonse and Sakharia varieties on May 22nd, 1912. Grafting was done by enarch from plants in small pots tied near the branches of the stock. On November 1st, 1912, further grafting was done from established scions on to new branches. Out of 40 scions thus placed, 3 flowered on January 22nd, 1914. As the first and second graftings were not distinguished it is impossible to say to which the flowering scions belonged, but it shows that, by top-working this tree, flowers were got on the scions in 14—20 months after grafting. The original plants in the pots from which the scions were taken had not flowered by this time. It seems rational to assume that the position at the end of a branch in the system of a big tree is likely to accelerate flowering.

In the Agricultural and Co-operative Gazette, Nagpur, Vol. IX, September 1915, page 15, the following passage occurs; "With

regard to mangoes it was found that the Bombay grafts were seriously affected by frost each year when grown at Pagara. The khuds and ravines of the Pachmari hills are full of wild mangoes and it has now been found that if the Bombay varieties are grafted on the wild Pachmari seedlings the resulting trees, without deteriorating in quality, are quite frost-resistant, a fact which is worth noting by many growers in the Central Provinces, who are troubled by the annual destruction caused by frost. This indicates a definite physiological influence of stock on scion."

Grafting on Stocks other than Mango.—Grafting of mango scions, on stocks of *Semecarpus Anacardium* was done on July 1910, by the crown, whip, saddle and tongue-grafting methods. The scions remained fresh a little and then died. Similar graftings were made on *Spondias mangifera* and *Spondias acuminata* but without success. A similar experiment was made in 1914 when 12 mango scions were enarched on to *Semecarpus Anacardium* stocks, on August 12th and November 3rd. Two mango scions were also enarched on to *Holigarna Grahamii* stock but none of these took.

Collins[1] says: "It is said that in Martinique, the mango has been successfully grafted on to the Cashew tree (*Anacardium occidentale*) and it is further stated that seedling mangoes so grafted produced fruit double in size, free from fibre, and with the seed so reduced that it is frequently without the power to germinate. The fruit, although melting and very juicy, is said to be without flavour." Collins comments: "These results as reported are so radically opposed to those usually obtained from similar experiments that they are not likely to be generally accepted until verified."

Time of Grafting.—The actual date of grafting will have to be varied to suit various climatic conditions. It may, however, be said that the best times for grafting are when the mango starts into new growth. In Poona, generally, there are three such periods per annum but in all climates the growth may not come at the same time.

Enarching can be done in India at almost any time of the year. Crown and side graftings require to be done in the rains.

[2]In the Maldha District of Bengal "if irrigation facilities are available the cultivators graft at any time of the year." Still those plants grafted during the latter part of the rains when the heavy showers are over, are better and more reliable; this is what one expects, as

(1) The Mango in Porto Rico, p. 19, quoting Jumelli's Cultures Coloniales, p. 202.

(2) Poona Agricultural College Magazine, Vol. III, No. 1, July 1911, p. 7.

it being the growing time, the sap flows freely. If the grafting is done in the rainy season, no irrigation is required.

Requirements for Grafting.—The tool necessary is a sharp grafting knife. For tying up the joint some kind of tape or cord is necessary, and usually sticky material to protect the wound.

Grafting wax and waxed tape made in various ways have been recommended chiefly by American writers.[1] [2] [3] In Poona, the recognised substitute for tape so far is *sopat*, the inner part of the sheath of the plantain leaf, cut into strips. This is usually first applied wet, and string tied above it and the whole covered with grafting clay made by mixing equal parts of fresh cowdung and clayey soil. This mixture answers admirably. The string is soft and coarse and is, in any case, padded by the *sopat* and so does not cut into the tender tissues of the tree.

Methods of Grafting.—These may be divided into two classes:—

(1) in which the scion is only partially detached from its parent plant while the junction with the stock is being made.

(2) in which the scion is completely detached from the parent plant and then joined to the stock.

In the first class come the following methods:—Enarch, Tongue, and Saddle. In the second, Crown, Side, Whip and Wedge. Various modifications of the above may be made, but these are the most important and will be described one by one. In all cases the cut surfaces of the stock and the scion must be smooth and even, so that the joining is perfect. The cutting of the scion and the stock should be immediately followed by the process of joining them together. The cut surfaces must not be allowed to dry up.

Grafting by Enarch or Simple Approach.—(See Fig. 5.)

This is by far the commonest system practised by nurserymen in Western India and is very simple. The stock in its pot is placed so that a branch of the tree from which the scion is to be taken is in contact with the stock. If necessary, the branches bearing the scions should be bent down and fixed conveniently. Where branches cannot be bent so as to meet pot plants on the ground, these pot plants must be elevated on a scaffolding to meet the scion branches. In the Konkan, the pots are tied to the branches of the trees close to the scions. By any of the above methods a large number of stocks can

(1) The Mango by Wester, p. 31, (2) Higgins, p. 11. (3) Woodrow, p. 20.

be grafted on from one tree. The branch of the scion is brought close to the stock, and at the point of contact a thin slice of bark and wood is removed from each. The slice may be two or three inches long, $\frac{1}{4}$ inch broad and about $\frac{1}{8}$ inch deep. The cut surfaces should fit each other so that union may be perfect. The cut surfaces should immediately be tied together and covered with grafting clay or wax. It takes nearly two months for perfect union to take place. A month and half after grafting, a cut is made in the scion between the point of junction and the parent tree. This cut is deepened after a week and the scion completely severed after another fortnight. The original top of the stock is then removed. The cuts are later on trimmed and the cut ends tarred.

Woodrow[1] says : " The graft is, by some people, permitted to remain attached to the large tree for an indefinite time and the result is swelling at the point of union from the constriction of the bandages and an unsightly union which may be avoided by removing the graft early and placing it in moist shade for a few weeks. When it is found that union is complete the bandage should be completely removed and replaced by another bandage not very tightly applied, to permit swelling. After a few months, careful dressing off snags with a sharp knife will induce a clean stem and finish the graft." While the pots containing the stocks are on the tree and the union is going on, water should be given to the pots daily so as to keep the soil moist but not water-logged.

Tongue Graft by Approach.—This is a modification of the previous method. Instead of merely making a paring of stock and scion, a tongue is cut in each, so that they fit together as in Fig. 7. By this means there are three surfaces of union instead of one as in enarching. The outside of each tongue must be pared in order to expose the cambium layer which makes the union.

In Ganeshkhind Botanical Gardens, 58 enarch and 41 tongue grafts were made from the same tree, to test the relative success of the methods. Of these, 16 of enarched and 7 of the tongue-grafted plants failed, thus the percentage of success in the two was 72·4 and 82·9 respectively. This difference, though not striking, indicates that there is greater percentage of success in the tongue-graft than in the enarch. This is as one would expect as there are three surfaces of union in the tongue graft.

Saddle Graft.—This to some extent resembles tongue-grafting since a tongue is actually made in the scion branch. This however

(1) The Mango, pp. 16 and 17.

is fitted on to the stump of the stock left after completely cutting off its top (Figs. 2 and 3). The top is trimmed to a point by cutting along two sides so as to fit the tongue of the scion.

Whip Graft.—This resembles saddle grafting but the scion is from the first completely removed from the parent tree (Fig. 8).

It is inserted on the stock in the manner shown in Fig. 8. The leaves should be removed from the scion. The cut is tied up in the usual way. Our experience as to percentage of success by this method is somewhat varied. In the Ganeshkhind Botanical Gardens the percentage of success was small, while in Bassein Gardens on the coast in the hands of another operator, the percentage of success was high. In the latter garden, whip-grafted trees produced fine straight stems and flowered three years after planting out.(1)

Wedge Graft.—This is the reverse of the saddle graft. With the scion completely cut off the tree and pointed so as to fit into a cleft in the apex of the beheaded stock. (See Fig. 1.)

Crown Grafting.—This system is adopted to renovate old and useless trees or wild trees having undesirable fruits. It consists in beheading the trees at a distance of two to three feet from the ground with a saw and then inserting the scion in the form of a wedge in the slit of the bark prepared for it. (See Fig. 6 a, b, and c.)

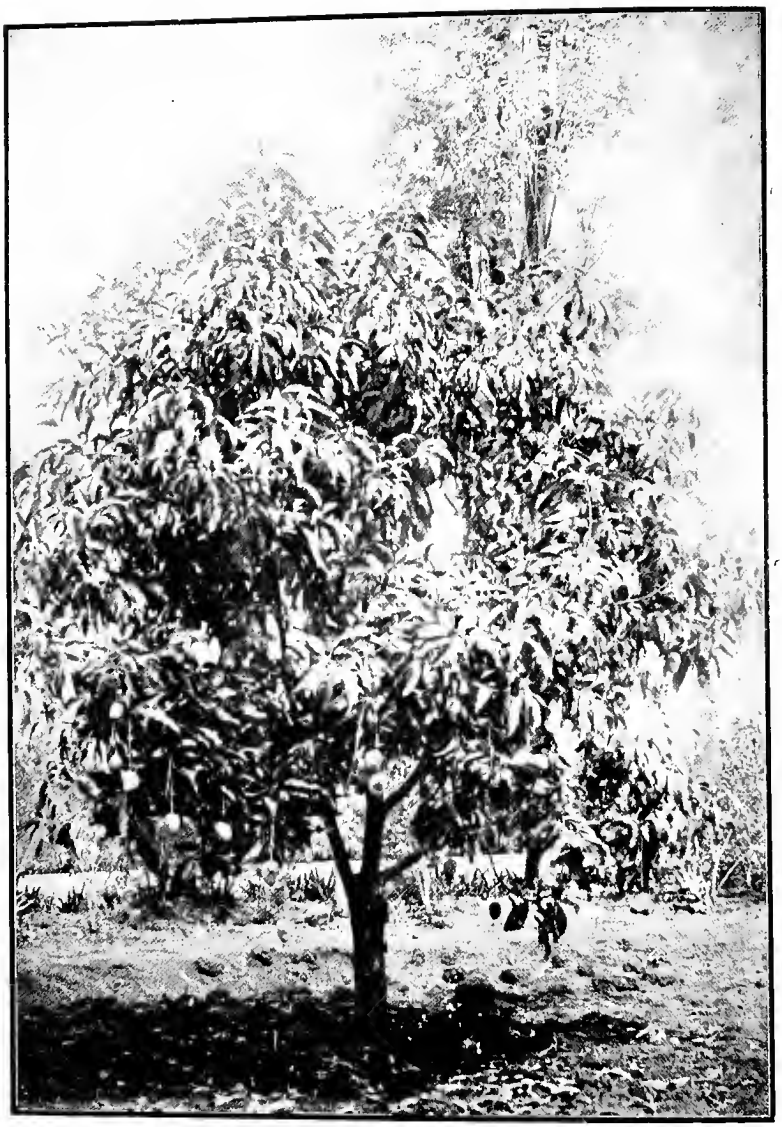
In the case of a very large tree it is desirable to cut off many of the branches before sawing through the tree trunk. More than one scion can be inserted according to the thickness of the trunk. For each scion a slit is made about 6 inches long, cutting from below upwards, taking care not to injure the wood. The sides of the cut are then eased out gradually by a piece of hard wood or smooth bone and the scion cut in the form of a wedge is then gently pressed from above into the space so prepared. The tree trunk is then firmly bound with coir rope and sacking is put over the cut end of the scion, the whole being covered with grafting clay. If the bark of the stock splits, then two parallel incisions of equal length are made at a distance of two to three inches and the scion is then inserted between the incisions.

From our experience the percentage of success by this method has been exceedingly small due perhaps to faulty watering of the stocks, weakness of the stocks or dry climate. In those cases where the graft succeeded, the scion has made excellent growth and has

(1) See also Wester, pp. 33-34, for a type of whip grafting quoting Trans. Agri. Soc., India, 1838, Col. II, p. 260.

No. 1.

Mango Budding.



A crown-grafted mango fruiting for the first time after grafting.

produced flowers from the third year after grafting. Photo 2 shows the fruiting of such a grafted plant.

Side Grafting.—This method has previously been fully described by one of us.[1] The method is as follows. (See Fig. 4.)

A transverse cut 1½ to 2 inches in length is made in the stock at a distance of 9 inches to 1 foot from the ground. Above this a triangular notch two to three inches in length is cut out. The chief object of cutting is to stop a small portion of the descending sap in order that it may be absorbed by the scion. When a triangular cut is thus obtained, a longitudinal incision in the middle of the horizotanal cut is made and is carried downwards very carefully up to the length of four to six inches according to the strength of stock and scion. The bark is then loosened for making way for the scion of the desirable variety. This is generally done by means of a small piece of hard wood cut in the form of the scion as the instrument is frequently insufficient for raising the bark. Care is taken not to bruise the inside wood. The scion is then inserted in the opening made for it and is gently pushed down till its shoulder rests on the top of the stock. Further treatment is just the same as for other kinds of grafting. After two or three months when the graft has taken, the earth is heaped over the grafted portion, the head of the stock is cut off and only the scion is allowed to be seen. Watering is given every alternate day, if there is no rain and is continued for about six to eight months till the graft becomes sufficiently established.

In the coast districts of the Bombay Presidency and in Goa, this method is commonly practised apparently with good success. Our own experience in a drier tract has not been encouraging. The advantages claimed for the method are :—

(1) that the whole tree is not sacrificed if the graft fails to take ;

(2) the method can be used on trunks up to 3½ feet thick provided the bark does not split ;

(3) as the graft can be made on well established plants with a large root system, the tree is said to grow vigorously and to bear profusely ;

(4) it can be used for the improvement of country mangoes growing in the field.

(1) Prayag S.—Agricultural Journal of India, Vol. VIII, Part 2, April 1913.

Mention of this method is made by Wester.[1] He recommends the use of Sphagnum moss and a small cylinder of tarred paper placed around the grafted plant. He says this method has been used in Florida with some success.

In comparing the various methods of grafting there is no hesitation in saying that for all ordinary purposes simple enarch on a one year old seedling is the best. The percentage of success is high and the operation is easy. Tongue graft by approach requires a thicker stock and scion. There are three surfaces of junction, thereby perhaps giving a greater chance of union, but also undoubtedly, on account of the complicated nature of the cuts, causing a certain check to the flow of sap for a time. Whip grafting is anticipation in the hands of one accustomed to it, and in a very damp climate, but cannot be recommended for operators of small experience, or in a dry climate. The crown graft, when it succeeds, is an admirable method of renewing old trees and the side graft is quite as good. The side graft is the safer as the top of the tree is not sacrificed in anticipation of the result. Crown-grafted trees make vigorous growths and fruit in about six years from grafting. They may flower earlier than this.

Top-Working.—The term "Top-working" is used to describe the operation of renewing the top of an old or worthless tree. The top is severely pruned. Many branches spring up. While these are young, scions of desirable varieties are grafted on them. The following is a case :—

A country tree in Bassein Botanical Gardens of unknown age but probably over 30 years old, was heavily cut back on March 6th, 1912. Many new shoots sprang up from the stumps, and on these were grafted scions of good variety on May 22nd, 1912. The grafting was done from plants in small pots tied to the tree at various places. On 1st November 1912, further grafting from the established scions on to new shoots of the stock was done. Out of a total of 40 scions, 3 flowered on 22nd June 1914. As the first and second grafting were not distinguished it is impossible to say to which the flowering scions belonged, but it shows that by top-working flowers can be got on scions 14—20 months after grafting. The pot plants from which the scions were taken did not flower. The experiment is rather interesting as showing that the position of the scion on the tree has some effect on the time of flowering. It is rational to suppose that a mature scion grafted on the outer branches of an old tree will flower sooner than one grafted on a young stock.

(1) The Mango, p. 34.

The first crop of the tree was got in June 1916 when 38 fruits of the following varieties were harvested fom the same plant :—

30 Pairi
2 Alphonse
4 Batli
2 Sakharia

These fruits all had their natural characters.

In Ganeshkhind Gardens an old country tree was pruned heavily in the rains of 1913. Eight scions were top-worked on it in July 1914. These had not flowered in June 1916.

In the Philippines top-working[1] has been recommended for renewing sterile trees, budding being employed instead of grafting on the shoots appearing after the heavy pruning. There is no doubt that where budding or whip-grafting is successful top-working is a paying operation, but if top-working has to be done by enarching from trees in pots, then the labour and trouble may outweigh the advantages. Moreover, by the latter method only a few of the many shoots can be operated on and in dry seasons the watering of the pots is a difficut problem.

Budding.—In foreign literature much has been written regarding the budding of the mango. Knight[2] in Queensland reported success in " bark grafting ". " Patch budding, " the same as bark grafting, was tried in Florida by J. W. Oliver.[3] Patch budding not being very successful, " Shield budding " was adopted. This was first tried for the mango by Wester in the Philippines in 1904 but Mr. Orange Pound[4] of Coconut Grove, Florida, achieved great success in this direction.[5] J. E. Higgins also tried the method with success.

Patch budding is the removal of a small square piece of bark from the stock and fitting in, another piece (presumably containing a bud) in its place. Shield budding is really simply inverted T budding.

" In April 1899, a series of experiments in mango budding were begun at Saharanpur. Buddings were made at intervals of a fortnight till the end of August. The stocks were two to three years old

(1) Wester, The Mango, p. 37.

(2) Queensland Agri. Jourl. for July—September 1910, p. 256.

(3) An Article published in the Florist's Exchange, New York, April 19,1902, p. 461, under the heading " The propagation of the Mango ".

(4) Rural New Yorker, September 10, 1910.

(5) Bulletin 20, Hawaii, 1910.

and from four to six feet high, with a stem diameter of ¾ to 1¼ inch. There was only one successful case which was a budding made on July 4th, 1899. It began to sprout a month after insertion. In 1900, the experiments were repeated at Saharanpur. Success never averaged over 5 per cent. The experiments were done for five or six years continuously. It was particularly noted that the commoner varieties such as Bombay Maldha were unsuccessful. Success was got with the lesser known varieties such as Langra, Naspati, Safaida, Tamancha, etc."

Mr. P. D. Graham, M.A., D.Sc., Economic Botanist of the Central Provinces (now Lieutenant-Colonel Graham, Director of Agriculture, Bagdad) says in a letter dated 1st January 1914, "Only once, to my knowledge, has the mango been successfully budded in the Central Provinces. The method used was the same as for oranges. I have tried it more than once but have never succeeded."

Our own experience in the Ganeshkhind Botanical Gardens has been as follows :—

On August 12th, 1910, shield-budding the mango was tried on seven stocks in pots and on eight stocks in pots on August 29th, but without success. In 1911, 33 shield and 7 patch buddings were done on stocks in pots. All were unsuccessful. On November 8th, 1911, seven shield buddings were made on stocks in the field. One of these was successful. This made four growths during the year. The first flush occurred on December 26th, 1912, and the others on February 6th, March 4th, and May 16th, 1912. (See Photo No. 1.) In 1912, 13 shield buddings of Pairi on country stocks were done in November. Ten more were done in May 1913. All these two lots were unsuccessful. In 1913-14 budding was done on an extensive scale. The number of successes was only 8 per cent of the total number of buds inserted. The buds were from Pairi or Alphonse trees. The bud-wood was fully matured and of a dark colour. The bud was always swollen, with the outside scale-leaf just opened. It was found rather difficult to separate such a bud. Shield buddings and Patch buddings were both done. Pot plants were found unsuitable as budding stocks, since their bark did not separate easily from the underlying wood. The stocks used were seedlings 2½—3 years old standing in the field. After the bud was inserted there was a considerable pause before it began to grow. In the case of the successful buddings the

following are the actual dates of the operations and the inception of growth in the bud.

Date of operation.	Date when growth of buds started.	Interval days.
24th September 1913	.. 29th October 1913	.. 36
25th September 1913	.. 29th October 1913	.. 35
29th September 1913	.. 24th December 1913	.. 87
29th September 1913	.. 29th November 1913	.. 62
17th October 1913	.. 25th November 1913	.. 40
17th October 1913	.. 1st December 1913	.. 46
27th October 1913	.. 1st December 1913	.. 36
29th November 1913	.. 1st December 1913	.. 34
8th November 1913	.. 28th December 1913	.. 51
18th November 1913	.. 18th February 1914	.. 93

The period before the bud starts growth is therefore much longer in the mango, than in Citrus. In the latter case the resting period (in Poona) is about 20 days. It will be noticed from the above table that there were two abnormally long periods of dormancy, lasting 87 and 93 days respectively. It is astonishing that the buds should have kept alive for so long a time when there was little or no rain. After the buds once started growth, they made excellent progress, and in some cases produced a shoot 4 feet long within the ensuing six months.

A few buddings were made in 1914-15, to ascertain if budding is successful in wet weather, as the trials in previous years had been made after the rains. Only one bud inserted on August 15th, 1914, succeeded. This sprouted on 12th October 1914, and grew vigorously.

In August 1914, 26 buds from Alphonse trees were inserted. Three of these took. These particular buds were inserted on August 18th, 1914, and germinated on February 1915 and the other two in March 1915. This also shows the extraordinary long time the bud can live on the tree before germination occurs.

To sum up : in Poona, mango budding is as yet an uncertain means of propagation. No satisfactory explanation can be offered for this. In Saharanpur and Nagpur, similar lack of success is reported. In Florida up to 80 per cent. success has been claimed. In India, therefore, the writers cannot recommend this method of propagation until a similar percentage of success is assured. In successful cases the bud grows vigorously, and in one case observed by us, flowered four years and three months after the operation, but set no fruits.

Wester[1] says: "Seedling mangoes are ready for budding when they are about a metre high. Bud-wood should be taken from the first, second, and third growth, well matured, from the end of a branch. Such bud-wood is always green and smooth. About three weeks in advance of the date when the budding is to be performed, cut off the leaf blades of the selected bud-wood while still on the tree. This causes the leaf stalks to drop. When the scars are well healed the bud-wood is in condition for budding. The buds should be cut about 4 cm. long with an ample wood shield and inserted in the stock at a point where the bark is *green and smooth* like the bud-wood, not brownish or greyish and rough. Use waxed tape for tying and cover the entire bud. When in the course of two or three weeks a good union has formed unwind the wrapping and expose the leaf bud and cut off the top stock 10-15 cm. above the bud. Thereafter promptly rub off the wild sprouts whenever they appear in order to assist the inserted buds to make a growth, which otherwise frequently are very dilatory in starting. When the buds have made a growth of about 30 cm. cut off the stock immediately above the bud.

Note.—The budding knife should be kept clean and the edge so sharp that it readily shaves the hair on the forearm."

CHAPTER III.

Planting.

Assuming the climate to be such that mango trees will live and thrive in it, we have now to consider the siting of the plantation. Deep alluvial soil near rivers is ideal, but the plantation must be made above the flood level, for the young trees will not tolerate being submerged for any length of time. Virgin soil of forests or grass lands, and cultivated ground is suitable provided it is over three feet deep and has a well drained substratum. Sites exposed to violent winds are unsuitable unless an effective wind-break can be constructed. The sites of hills are suitable if the underlying rock is laterite. In all sites there must be an ample water-supply, for the plants require artificial watering for at least five years. In considering the question of site the mango trees must be considered as the main crop of the plantation. We have seen mango trees grown as subordinate crops in betel-vine plantations, citrus gardens and rice fields. In no such condition can they be really paying.

(1) Rural New Yorker, April 29, 1916, p. 697.

Treatment of land previous to Planting.—Assuming that we are considering suitable cultivated soil of over 3 feet deep with a well drained substratum, the first necessary operations are thorough ploughing and harrowing before the ground hardens after the rains in order to kill weeds and aerate the soil.

In the case of virgin land the existing tree growth must be cut down and all stumps removed. Low scrubby growth should be burnt and the whole area brought under the plough to incorporate the ashes into the soil and break it up generally.

The question of the preparation of hillside is attended with some difficulty. In the laterite regions, the Ratnagiri practice is recommended. This consists in clearing the jungle growth and pits are made at the required distances. All deep rooting and troublesome trees near such pits are removed and their roots dug out. Contrivances are made by levelling and damming to let the rain water saturate the ground. The hill soil near Ratnagiri itself is very crumbly laterite and the necessity for tilth and aeration is not so great, even if tilth were possible.

Before planting trees the land must be levelled and arrangements made for drainage. In an uneven piece of ground water collects in hollows and trees in such parts are likely to suffer from water-logging during the rains especially in clayey soils. A rough but effective method of determining the level of the soil is the following :—

Make three T squares of wood. Get also a straight bar of seasoned wood about three feet long with smooth level faces. The other requirements are a number of stout wooden pegs of length varying from one foot to six feet and a spirit level. Two short pegs are driven into the ground till the bar resting on them is absolutely horizontal as shown by the spirit level. A third peg is inserted in the field at a suitable distance away and roughly in line with the two first pegs. A T square is erected on each of the first two pegs and a sight taken on to a T square held on top of the third peg. This peg is then lowered or raised until the top of the T square is level with the line of sight across the first two. Intermediate pegs can then be inserted and cross levels taken from them. By this means the land can be made absolutely level or given any desired slope. The slope should not be above 5 inches per 100 feet, otherwise the land is liable to be washed and eroded. As a rule, a slope of two inches per 100 feet will give the neceessary fall to allow irrigation water to

travel easily but there may arise cases where levelling to this extent would be more expensive than profitable and levels up to but not exceeding five inches per 100 feet may be taken.

By drainage we mean arrangements for the run-off of superfluous water. Drains are of two kinds, surface drains and sub-soil drains. Surface drains are shallow channels to permit of the escape of the surface water ; sub-soil drains are trenches or lines of buried porous pipes, or underground channels loosely filled with rough stones or similar materials providing large interstices for the travelling of water. Surface drains prevent the sweeping away of the soil from the surface but care must be taken that they themselves are not mere carriers of soil. For this purpose it is well to have one or more silt pits in the course of the drain where the water may deposit its soil before going on. Surface drains may be made parallel to the slope while sub-soil drains should be at a slant across the slope, not at right angles to it, however. The depth of a sub-soil drain will depend on the nature of the soil. It is important to see that open sub-soil drains are left clean. All drains must have a final fall into a nala or some such outlet. Sub-soil drains are really necessary only in areas of very heavy rainfall where the soil is stiff.

Distance between Trees.—After the land has been levelled it should be marked out for the trees, a stake being put at every point where a tree is to be planted. The distance apart at which trees should be planted has been the subject of considerable discussion both by Indian and American writers. Wester[1] gives 10 metres (about 33 feet) as the minimum distance at which a tree should be planted. Our experience coincides with this and for this country we can recommend 30 feet as an average distance for mango tree planting. We do so, on account of the prevailing tendency to plant all kinds of trees thickly, apparently under the impression that the more trees per acre the more fruit. In the Ganeshkhind Botanical Gardens grafted mango trees were planted from 15 to 20 feet apart. The result was that they crowded each other and produced leaves and fruits only at the tips of branches which struggled for light. When the trees were 25 years old it was imperative to cut out every alternate tree in order to let the others have a chance. This could have been avoided if the trees had been planted 30 feet apart both ways. It must be remembered that a healthy grafted mango tree may live for at least 50 years and in that time branches grow to cover a considerable area. Each tree must have light and air at all stages of its growth.

(1) The Mango, p. 40.

No. 3.

Comparison of root system of one year old mango plant growing:—

(a) in ground after transference from a pot.

(b) in pot.

(c) in ground.

Comparison of root development of two years' old grafted plant in a pot and a seedling plant in ground.

(a) seedling in ground.

(b) grafted plant in pot

It is a fact that a newly planted mango grove with small trees standing at 30 feet apart looks rather a desolate spot and the impatient cultivator feels that a mistake has been made and that these trees will never cover the ground. Experience, however, teaches that the ground between is not waste land, as will be shown later. The ideal distance is that at which the trees will attain their maximum development and at the same time leave no unnecessary space between them. As a generally suitable distance we, therefore, recommend 30 feet apart each way.

Planting.—At 30 feet apart, pits should be dug, each 3′×3′×3′. The soil so excavated should be kept at the side of the hole. The pits should be dug in the hot weather previous to the monsoon, and should also be filled before the rains break, otherwise they become filled with water to the detriment of the plants later put in. The question of placing manure in the pits has been discussed by Woodrow[1] who recommends putting 20 lbs. of fresh bones at the bottom of each pit and mixing the surface soil with manure (quantity not stated) to be put in the layer which will hold the roots of the young plant. The putting of a layer of crude bones at the bottom of the pit is of doubtful efficacy as these bones take a long time to disintegrate and are, moreover, not mixed uniformly with the soil surrounding the root. We recommend mixing 1 cwt. of well rotted farm yard manure with the earth to be placed in the pit, *plus* 5 lbs. bone meal and 10 lbs. wood ashes. No raw manure should be in contact with the roots.

There are two methods of planting out a garden with grafted mango plants. One is to transplant plants in pots previously grafted and the other is to plant seeds of stock plants in the field at the required distance and graft on these plants *in situ*. The relative merits of these two methods may now be discussed.

The mango seed, when it germinates, rapidly produces a powerful tap-root which in the field goes deep into the ground and branches to produce a large and efficient root system. (Photo Nos. 3*c* and 4*a*.) In a pot the tap-root soon encounters the bottom of the pot and then twists round in various directions (Photo Nos. 3*b* and 4*b*); side roots are developed and in a short time the pot is full of a matted and twisted root system, very different from the deep well-spaced system of a plant growing in the field. Plants which are kept too long in pots find it difficult to develop a root system suitable to the field on account of the twisted mass of roots in the pot and when transplanted are delayed (even for years) in their growth. The transplantation of seedlings

(1) The Mango, p. 11

(grafted or otherwise of one year or more not grown in pots) is usually attended by a large percentage of deaths. The only method by which transplantation from pots can be done is to graft and transplant at a very early date, and as a rule this method is not commercially useful since people have a prejudice against buying small grafted plants.

If seeds of stock plants are planted in the field at the required distance, each makes a natural root system and growth is vigorous. To graft on stocks in the field, the method of enarching from already grafted pot plants is most generally useful, although other methods may be employed where conditions are favourable. For example at Kansule, Khanapur, District Belgaum, a plantation visited by one of us was started by country seeds and, when 7 or 8 years old, was side-grafted to various good varieties by an expert Goanese. This grafting was done on 75 trees in the rains of 1911. Out of these, 20 grafts succeeded. In May 1914, one of these bore 10 fruits. All of them bore flowers at the same season but did not set fruit. This method of side-grafting may prove successful in heavy rainfall districts where the air is very moist and there is no danger of the scion drying up, but for drier districts the method of enarching on to younger stocks is preferable.

Wester[1] suggests budding on stocks in the field. Arekar[2] describes the method of enarching on young stocks in the field and cites the following advantages :—

(1) The expense of watering is reduced.

(2) Two or three stocks in the field can be grafted on from one single grafted plant.

(3) The resulting plants grow vigorously as the root system is not disturbed, and the plants attain great size.

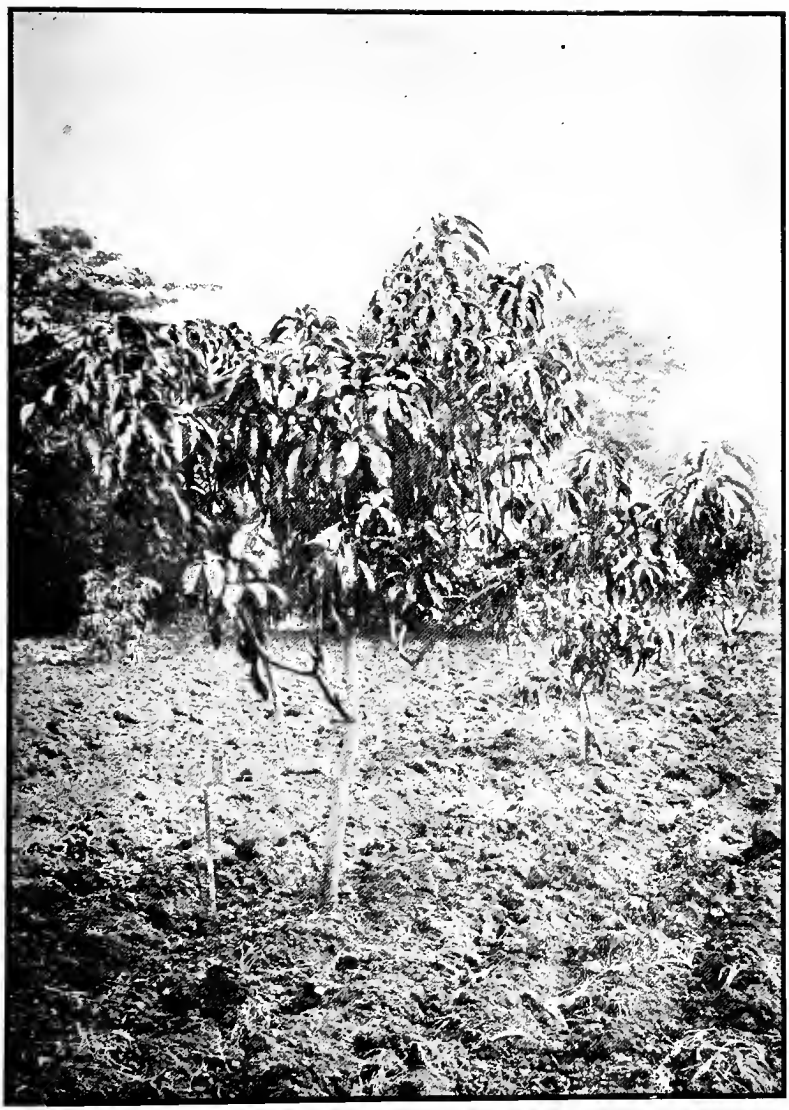
In the Ganeshkhind Botanical Gardens the method was tried in 1911 on four seedlings, two succeeded and one attained 8 feet in length and flowered on 13th February 1915. No fruits set (Photo No. 6). It flowered also in 1916, without setting fruit. Higgins[3] recommends the method for use where grafted plants are received with a badly cramped root system or with reduced vitality due to long transplantation. He says " by this simple adaptation a shoot only a few inches in length has been made to produce a tree top of 5 feet spread and 4½ feet height in less than a year."

(1) The Mango, p. 40.

(2) Shetki and Shetkari, pp. 206-207.

(3) Shield budding the mango, p. 16.

No. 5.



Five years' growth made by a grafted plant after transference to field.

Five years' growth made by a Pairi Craft on a two year old seedling ***in situ.***

Woodrow[1] indicates a method for the saving of weak grafted plants. He recommends the planting of five mango seeds near the weakly tree and the grafting of the weakly tree on to the strongest of the five seedlings. The others are then pulled out.

The employment of this method means that after planting the seeds a period of 12 to 18 months must elapse before the resulting plants can be grafted. As a rule, a cultivator desires to see his ground full of grafted plants as soon as possible and hence prefers to plant, at once, already grafted plants brought in pots.

If the method of grafting on stocks in the field is selected, then three or more seeds should be sown in each pit and the grafting done on the strongest seedling, the others being pulled out.

If pot plants are to be planted, the pot, if of the narrow-necked type, should be broken ; if of the cylindrical type the whole cone of earth should be removed with the contained roots and the mass sunk in the middle of the pit with its surface about 2 inches below the soil level. Mixed earth and manure should then be spread evenly over the surface and the whole trampled and rammed. A thorough soaking should then be given. It is best to plant in cloudy weather or if in sunny weather then in the evening.

Season of Planting.—Where the rainfall is less than 60 inches, planting should be done at the break of the rains. Thereby, the plants get the benefit of more or less continuous moist weather which enables them soon to recover from the shock of transplantation and to lay hold on their soil surroundings. Where the rainfall is over 60 inches per annum, it is desirable to plant about the end of the rains. Water-logging of the plant is thus avoided and full benefit is taken of the soil moisture and of the atmospheric moisture which persists after the rains for some time. If it should so happen that the proper planting time has been missed, it is still possible to plant, but great precautions have to be taken as to regular watering and protection. On the whole, in such cases it is desirable to wait till the next planting season.

After Care.—The area in which the plants are put, must be thoroughly fenced in or each individual plant must be fenced in to prevent cattle and goats devouring the tender shoots. A mango plant may easily be killed outright by these animals in a short time. Again, plants which have passed their life in shade or semi-shade often succumb on account of the sudden exposure to which they are subjected in the field. To avoid this, plants which have not previously been hardened

(1) Woodrow : The Mango.

should be protected by a small tent-shaped shade of dried grass for at least a fortnight. Collins[1] recommends the planting of Bananas between the mangoes to protect the latter. We have no experience of this as regards mangoes, but have seen the method succeed with other trees.

If flowering shoots (inflorescences) appear on the newly planted tree in the first three years such shoots should at once be removed. They seldom set fruit and if fruit is set, it only takes away from the tree the strength that it should be putting into its frame-work of branches. Any shoots that arise below the point where the scion unites with the stock should be cut off close to the stem of the stock and the cuts covered with tar.

Mention has been made of the transplantation of small mango seedlings. When seedlings are allowed to remain in the ground for more than a year or two their transplantation will have to be done with care as the tap root has penetrated deep and lateral roots have formed in abundance.

The following precautions are to be observed in transplanting :—

(1) The soil surrounding the plant should not be dry, as the roots are likely to be exposed if this is the case. If the soil is dry, the earth round the tree should be artificially moistened. The area to be moistened depends on the age and the vigour of the tree.

(2) The transplantation should, if possible, be done in the rainy season, as thereby the amount of watering to be given after transplanting is much reduced.

(3) There should be a big ball of earth removed round the roots of each plant. It has been found by experience that plants with naked roots transplant very badly.

(4) We have been able to transplant even 4½ years old trees without pruning the top, and with little damage to the roots.

(5) A temporary tent-shaped shade of grass should be erected for each plant after transplantation and should be allowed to remain till the plant becomes sufficiently established.

(6) It is always preferable to transplant when the trees are not in flush.

(7) In the case of large plants the ball of earth should be surrounded by sacking and firmly tied before removal. The sacking is removed on the plant reaching its new site.

(1) The Mango in Porto Rico, p. 19.

CHAPTER IV.

Further Care.

Manuring.—The manuring of mango trees as practised in the Bombay Presidency varies considerably. In the Dharwar District and in Ratnagiri, choppings of *Opuntia decumana* (Nivadung) and *Euphorbia neriifolia* (Thor) are placed in the pits mixed with 40 lbs. farm yard manure per pit. In one or two cases the refuse of the slaughter-house has been used. In a private cultivator's ground in Dharwar District the following was given :—

> Big bone pieces *plus* soil from old houses ; farmyard manure 20 lbs. *plus* 2 inches red earth. In another place tank mud and red earth were put in the pits. A common practice in the Deccan is to put 80 lbs. farmyard manure in the pits.

We have already (page 31) given our recommendations regarding the filling of the pits. The purpose of this mixture is to give nitrogen, phosphorous, and potash in a form readily obtainable by Indian villagers and landholders. We recommend 20 lbs. farmyard manure per tree for a one-year old tree and an increase of 10 lbs. per tree per annum up to 100 lbs. per tree. Similarly bone meal at 5 lbs per tree for a one-year old and an increse of one lb. per annum up to 15 lbs. per tree. Ashes at 10 lbs. per tree and increased by 2 lbs. per annum up to 30 lbs. per tree. The manure should be well dug into the ground in a trench 2 feet broad, 6 inches deep and 1 foot from the trunk in a one-year old tree. Widen the trench 6 inches per annum and take its inner edge 6 inches further from the tree per annum. The best time to apply the manure is at the break of rains. If artificial manures are given they should be applied at the end of the rains. Where intercrops are not taken at the break of the rains, green manuring may be used. In this case, the amount of farmyard manure per tree may be reduced by one quarter. Where intercrops are taken the system of circular trenches may be exchanged for long narrow trenches and the intercrops fitted in between these.

Salt Manuring.—Woodrow[1] says : " The mango growers near Mazgaon, Bombay, who produced such famous fruit before the land was occupied with cotton mills, applied 10 lbs. of salt to each tree at the end of September. This would arrest growth during October and November and encourage the formation of flower buds. In a moist climate and the intervening ground occupied with irrigated

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(1) The Mango, p. 14.

crops, this system is highly commendable, but with a dry climate is unnecessary."

To test the effects of salt manuring at Poona, experiments were made in 1911-12, 1912-13, and 1913-14. The same four trees each year received 10 lbs. of salt, and four trees were used as controls. The results were :—

Treated trees.	Date of salt manuring.	Date of flowering.
Pairi 72	20th November 1911	27th February 1912.
	21st October 1912	18th January 1913.
	27th October 1913	17th February 1914.
Pairi 73	20th November 1911	Did not flower.
	21st October 1912	18th January 1913.
	27th October 1913	17th February 1914.
Pairi 84	20th November 1911	Did not flower.
	21st October 1912	18th January 1913.
	27th October 1913	17th February 1914.
Pairi 106	20th November 1911	27th November 1912.
	21st October 1912	18th January 1913.
	27th October 1913	17th February 1914.
	Unrested tree (Controls).	
Pairi 83	....	27th February 1912.
		18th January 1913.
		17th February 1914.
Pairi 85	....	Did not flower.
		18th January 1913.
		Did not flower.
Pairi 105	....	Did not flower.
		18th January 1913.
		17th February 1914.
Pairi 153	....	Did not flower.
		20th January 1913.
		Did not flower.

From the above no definite conclusions can be drawn. In those years in which the trees flowered, there is no perceptible difference between the flowering times considered as a whole. In the untreated trees there are two more cases of non-flowering but this may be due to other causes. Salt manuring seems therefore to have no effect on the time of flowering.

It is a common practice in the Konkan to apply salt as a manure to mango trees. The efficacy of this is doubtful. The experiments reported in *Bombay Agricultural Department Bulletin* 59 of 1914 are not convincing, being only for one year. The use of salt has been explained as (1) to keep off white ants, (2) to retain soil moisture,

(3) to give vegetative growth a check and allow of flowering. None of these points have been proved. On the other hand, it is absolutely certain that mango trees do grow and bear heavily without any application of salt. Its use may, therefore, be disregarded, until more conclusive evidence as to its value is forthcoming.

Irrigation.—Grafted plants should receive water on the day when planted in the field and thereafter every third day, if there is no rain. The intervals between waterings should be gradually increased and at six months after planting the waterings should be one per week. Pot-grown plants need special attention and frequent light waterings are necessary until they are well established. They are less hardy than trees grown in the field as far as the water supply is concerned. The reason is that their roots are all matted together and do not come in contact with the same amount of moisture as the large root system does. Moreover, their root hairs have been damaged by transplanting. In dry tracts such as Bijapur, Sholapur and Ahmednagar, the trees must be frequently irrigated during the hot weather. If inter-crops are grown in the plantation the water given to the inter-crops suffices, during its period of growth, for the mango trees also. In the Konkan, in some parts, grafted plants are put in during the rains and given no water at all afterwards. We have no data as to the percentage of success in this method. It is possible only in heavy rainfall tracts.

As a rule, a grafted mango tree requires irrigation for four years. By this time it has made a deep and extensive root system and except in very dry regions can persist without artificial watering. It is not desirable, however, to stop watering all at once. Watering should be given right up to the rainy season of the fourth year. Thereafter no water should be given unless the tree shows signs of withering, when a good flooding should be given. There also arises the question of irrigating established bearing trees and the general consensus of opinion is that water should be given during flowering. It should be given once a fortnight till the fruits reach their full size and should then be stopped to allow the fruits to ripen. To test this opinion we made an experiment in a garden of well established trees, irrigating one portion as above described and leaving the other dry. There was no appreciable difference in yield or quality between the two plots. In the Ganeshkhind Botanical Gardens, Kirkee, no irrigation at all is given to the well established trees and the fruiting and ripening are normal. The question requires further experiment on two similar plantations, the sub-soil of which is not connected. If artificial manures

are given in October, watering is necessary to take the material into the soil. The method of irrigation we recommend is a long broad trench on each side of a row of trees.

Pruning.—The mango tree growing wild assumes a graceful dome-shaped form with a clean stem of a height ranging from four to ten feet. The grafted mango tree often branches in a ragged manner from the ground level.

To obtain well shaped grafted mango plants the first desideratum is a properly made graft. Too often the plants sold by nurserymen are like those in Photo No. 7. The ideal is as shown in Photo No. 8, and this is easily produced by a careful choice of scions and correct grafting. Such a plant when put in the field proceeds to develop a strong straight stem. If the plant has not branched naturally when it reaches eight feet high the terminal bud should be removed and side branches will develop. Side branches, whether arising naturally or produced by topping, should be kept equal and one should not be allowed to outstrip its neighbour; otherwise a lop-sided tree results. If one branch shows a tendency to grow at the expense of the other, it should be shortened and one of its side branches allowed to take up the work of continuing its growth. The side branches of the main stem will themselves branch and should be cared for in the same way as the main stem. If the shape of the tree is thus attended to for the first four years, little care need be taken afterwards except the excision of dead branches and the removal of superfluous ones. So far we we have dealt with pruning for form only. Let us now consider the question of pruning for flowers and fruits.

The inflorescence of the mango is borne either as a terminal organ or in the axil of a leaf. Most observers appear to consider that only terminal inflorescences are produced. This however is not the case and a count of over 4,000 inflorescences showed 17·3 per cent. axillary among these. The wood on which the inflorescence appears varies greatly even on the same tree. The mango tree in Western India, as a rule, makes three woody growths (flushes) per annum which may be called the cold weather growth (October), the hot weather growth (March-April) and the rains growth (July). Other growths are occasionally intercalated, especially a growth in January-February simultaneous with the flowering of other branches. On all these growths, inflorescences develop. We have studied several hundreds of flushes from their inception to the time they flowered and are convinced that there is no possibility of pruning for flowers

No. 7.

Grafted plant as sold by Nurserymen.

No. 8.

An ideal grafted plant.

Axillary inflorescences near last year's inflorescence.

Inflorescence and vegetative growths side by side.

as any kind of pruning may lop off a potential flower-bearing branch. We have seen cases even of the following extreme types :—

(1) Wood which bore a terminal inflorescence last season bearing axillary inflorescences in the next season with no intervening woody growth. (See Photo No. 9.)

(2) A flush made in November flowering in the succeeding January (two months later).

(3) Wood of several years old and four inches in diameter producing an inflorescence.

(4) Axillary buds on the same branch developing simultaneously, some into inflorescences and others into woody growths. (See Photo. No. 10.)

Heavy pruning of old trees results in a vigorous production of vegetative branches and has no special effect on the flowering.

The only possible time to prune bearing trees is immediately after the rains. From January to June inclusive, flowers and fruits are on the tree. From July to September inclusive the rains flush grows and ripens. In October then, is the best time to prune (removing only dead and diseased branches and such as are obviously superfluous).

The following few rules for the successful pruning of the mango tree may be of use :—

(1) For large branches use a saw and immediately afterwards trim the edges of the stump with a sharp knife.

(2) For smaller branches use secateurs, but on no account use them for branches which do not yield readily to their action. If the secateurs leave a ragged stump, trim with a knife.

(3) Cut all branches, which have to be removed entirely, close to the trunk.

(4) Paint the surface of all cuts one inch or more in diameter with tar at once. In most cases a callus will gradually close the wound thereafter.

Intercrops.

When mango trees are planted at 30 feet apart, there is naturally a great amount of unoccupied space. During the first five years at least of the life of the plantation and later if the ground is not too shady short-season crops may be taken between the trees. Where water is scarce brinjals (*Solanum melongena*), guvar (*Cyamopsis psoralioides*),

potatoes and kulthi (*Dolichos biflorus*) are raised during the rains, in the Dharwar district in red soil. In medium black soil small Japanese and Spanish groundnut, peas and beans are raised. Where irrigation facilities exist, cabbages, knol-kohl, beets, turnips, onions, sweet-potatoes, have been grown successfully both in the Deccan and the Southern Maratha Country. In the Konkan, it is too often the practice to grow rice between the trees. This means water-logging in the rains and cracking of the soil later on. The trees suffer. They are scraggy and sick, and bear few fruits. Heavy feeding crops such as lucerne are also undesirable.

In some parts of the Southern Maratha Country jowar, tur and cotton are grown in mango plantations. These should not be grown between young trees as their shade interferes with the vigorous growth of the plants.

In Gujarat, there is a practice of growing *Piper nigrum* (black-pepper) under the shade of mango trees.

Wester recommends for the Philippines the growing of small, quick-growing, early-fruiting fruit trees between the mangoes. For vegetables, he recommends corn, sweet-potatoes, yams, rozelle, beans or any crop to which the land is adapted, provided the cultivation is not carried so close to the trees that the working animals injure them.

CHAPTER V.

Harvesting, Packing and Marketing.

Harvesting the Fruit.—The grafted tree begins to bear from its fourth year, producing from ten to fifteen fruits in its first bearing season. This number increases to 50 or 75 in its sixth year and up to 300 to 500 in its tenth year from planting, always provided the soil and cultivation are good.

Professional buyers of mango plantations are well versed in the operations of harvesting. Their employees use a small bag net at the end of a long pole. The bag net is about 15 inches deep and fixed to an iron ring of about 12 inches diameter and with two iron blades thereon whereby the fruit stalk is severed. The whole thing is called *khodi* in Marathi. The fruit after being severed by the iron blades falls into the net. This is then delivered into a bag net (called *Jheli*) capable of holding 300 to 500 fruits. For small trees this is not so necessary. The *Jheli* on large trees is tied on to a branch within reach of the *khodi* of the operator. When the *Jheli* is full it should

(1) The Mango, p. 41.

be lowered and the fruits are transferred either to carts or temporarily piled on a bed of leaves on the ground. In other cases the fruits are thrown one by one on to a cloth held under the tree by two boys. The tree is generally climbed but in case of rain three-legged ladders are used. Many large baskets are necessary for the carrying away of the fruit.

The mango is picked some time before it is ripe. If left on the tree till ripe it is generally spoiled by crows, parrots, etc., and keeps a shorter time. The exact time when picking should be done is a matter of personal experience. As a rule, when three or four semi-ripe windfalls are discovered and the fruits are full-sized, picking from that tree may commence. Woodrow[1] says "when a fruit is ripe, the gush of sap that comes from the hilum of the fruit quickly dries up and becomes a sort of gum. Fruit gathered in proper condition ripens without shrivelling and the mango sweated and ready for table is a charming object with glowing colour, smooth surface and most attractive odour. When gathered too early the sap exudes freely, does not agglutinate and the fruit shrivels." Rolfs[2] states that varieties differ in the time before ripening when they can be picked with advantage, and that in all cases if the fruit can be delivered to the consumer within two or three days, it should be allowed to remain on the tree till it begins to soften.

In some varieties the development of colour forms a good guide. For example, the Alphonse is picked when a slight yellow colour begins to be formed. The Shendrya is picked when a bright red colour is found on the exposed shoulder. The stage of picking depends on the distance to which the fruit has to be sent and the condition of the market.

In the case of Cowasji-Patel, which is used for preserves (Moramba), the fruits are plucked when they are fully developed but before coloration commences. We have at present no statistics to show the effects of early or late picking in different varieties either with regard to colour, flavour or lasting quality. It may be safely said that when mangoes begin to fall naturally from the tree (*pad fruits*) picking time has come.

There are in some places expert pickers who determine the right stage of picking and this is a specially remunerative part of the profession. They take the fruit between the thumb and the fingers

(1) The Mango, p. 22.

(2) Bulletin 127, University of Florida Agricultural Experiment Station, June 1915, p. 121.

and feel them carefully without squeezing. By some internal standard of judgment they pronounce the fruit ready or not.

In Ratnagiri, for want of shipping after May 15, fruits are plucked earlier.

In the case of Pairi and Alphonse, fruits are picked with the stalks attached as it is believed that fruits picked in this way last longer.

Our experience has been that the stalk withers and falls off a few days after plucking and makes no appreciable difference to the keeping qualities of the fruit. It is desirable, however, that the fruit should have a certain amount (say, an inch) of stalk to prevent the oozing out of sap all over the skin of the fruit and thereby spoiling its appearance.

Ripening.—After picking, the fruits must be kept cool and away from the direct sun. They are transferred to a store-house for ripening. The fruits are first spread in one layer on a bed of mango leaves at least four inches thick, and left there for two days exposed. They are then transferred to straw for ripening. In some store-houses half the space is reserved for spreading and half for ripening proper. The store-house should be well ventilated and not completely dark. Country varieties are kept in straw of *Iseilema Wightii* (Sheda). Three to five layers of such fruits are built up separated by two inches of grass. *Ischaemum sulcatum* (Pawna) is avoided as it is found to have the effect of retarding ripening. For superior varieties such as Pairi and Alphonse rice straw is used. This allows of uniform ripening and good coloration. Besides, it is soft and there is no danger of marking the fruit and so spoiling its market value. Two layers at most of such varieties are built up but it is desirable to keep only one layer. Fruits thus preserved in straw ripen about the sixth day and the whole lot is taken out for immediate sale. Sorting is generally done at this time but this would be better done at an earlier stage, namely, immediately after picking, as the fruits can then be handled without damage. If it is desired to delay ripening, then the fruits are not put in straw but are kept exposed on a bed of mango leaves. By this means the ripening can be delayed by about a week.

An experiment was carried out to test the relative keeping and ripening qualities of the Pairi and Alphonse varieties. Twenty-four fruits of each variety were used and an additional twenty-four of Pairi as a check. The results are as follows :—

The average time for which the first twenty-four Pairi fruits from one tree kept good was 15·5 days from date of plucking. The average

time for the second lot of 24 Pairi fruits from a separate tree was 16·1 days. The average time for the Alphonse fruits was 24·7 days. There is no doubt therefore that the Alphonse is the better keeper. The average losses of weight during ripening were 12·5, 13·2 and 18·2 per cent. of original weight, respectively, for the three lots above mentioned. All the Alphonse fruits, even when plucked green, coloured beautifully, assuming an orange-yellow hue. The Pairis coloured very feebly and were green to some extent, even when fully ripe. The Alphonse mangoes kept the firmness of their flesh till the last. The Pairis became watery very soon. The cutting of the mango fruit from the tree with a piece of stalk attached made no difference to its keeping qualities. At the same time there is no doubt that, especially in the case of the Alphonse, the bacterial infection which starts rotting gains its entrance through the open passage in the wound where the stalk was attached.

External blemishes and blackening do not necessarily indicate underlying putrefaction.

It would seem that if the stalk wound is healed with wax the Alphonse mango might be made to keep longer. When mangoes can be exported in cold storage, the Alphonse is the variety to export. During the above experiment the maximum temperature of the room in which the mangoes were stored ranged from 77° to 92° F. Each mango was enclosed in a muslin bag and suspended so as to have no contact with its neighbours.

In 1916, 50 Alphonse fruits were ripened as follows :—

Sixteen had their stalks removed and the scar closed up with melted paraffin wax, and 16 were left with stalks on. These 32 were enclosed in muslin bags and suspended in the laboratory, not touching each other. The remaining 18 were kept in straw in a box in the laboratory. All the fruits were from one tree. The average length of time that the fruits kept good were—

First lot of 16 (waxed)	..14·3	days
Second lot of 16 (not waxed)	..16·5	,,
Third lot of 18 (in straw)	..14·3	,,

The maximum temperature during the period ranged in the laboratory from 80° to 88° F.

The application of wax had no effect. The reason of this is that on removing the fruit stalks, sap gushes out and the wax will not settle properly on the wet surface.

The results so far show that—

(1) Rotting starts as a rule from the stalk.

(2) Fruits kept in straw ripen more quickly than fruits suspended in bags with free air circulation.

Higgins[1] reports certain experiments on the cold storage of mangoes at 34°—40° F. in which conditions he preserved fruits in good condition for 31 days. He says that probably mangoes will require different temperatures from temperate fruits. So far as is known this question has not been tackled elsewhere.

Packing.—Experiments carried out by us for several years show that the great desideratum is a light, thief-proof, rain-proof and well ventilated package which will take a fair amount, say, 75 fruits. If the package is not well ventilated then the fruits ripen too quickly *en-route*. Unless thief-proof, very few fruits will arrive at their destination and unless rain-proof the package will be soaked, as much of the fruit is gathered and sold after the rains begin. As a packing material we have used sann hemp fibre, dry grass and have also suspended the fruits in muslin bags fixed above and below on to trays. Soft dry grass is as satisfactory as anything, provided the fruits are wrapped in tissue paper and the usual cylindrical basket is satisfactory except that it can be easily tampered with. The sending of fruits to Marseilles, Trieste and London by Mail steamer (not in cold storage) was tried. The fruits so sent, with the exception of a few that arrived at Marseilles, were in a hopeless condition on arrival. The cost of sending was also very high. It appears that unless fruit can be sent in large quantity and in cold storage, there is no likelihood of developing an overseas trade.

Marketing.—The mango crop furnishes employment and profit to a considerable number of people of various classes. There are, however, no separate railway statistics for the number and value of the mango parcels carried per annum, but the number and value must be considerable. The mango plantations are disposed of in several ways which will now be described.

Sale of the Mango Crop[2].—During the months of January and February when the mango is in full bloom, the fruit merchants pay their visit to the mango plantations especially those that are within easy reach of Bombay, and make offers for the crop. The offers are also made in the month of April, as then the fruits are sufficiently

(1) The Mango in Hawaii, p. 18.

(2) Reproduced from the Poona Agricultural College Mag., Oct. 1915, Vol. 6, No. 2, p. 97.

developed and the attendant risk is not considerable. Thus in this system the mango is sold annually either in the flowering or in fruiting season to the highest bidder. Another system of selling the crop is also in vogue. It consists in selling the crop of the plantation on a three or five years' lease. In the latter system the loss of one year is counterbalanced by the gain in other years; and as such, it is not attended with any great risk; whereas, in the former system, especially when buying the plantation in the flowering season, the purchaser takes great risks as the inflorescences may get blighted by the prevalence of insects (Jassids), by fogs, or by untimely rain such as occurred in 1915. Though an experienced merchant takes these facts into consideration before speculating, yet, on account of some unforeseen circumstances, such as the frost of 1911, the prevalence of rain in 1915, or a heavy unexpected storm, there may be a considerable drop in the number of fruits left on the tree, with the result that the buyer is put to great loss and the grower does not realise the full amount of money promised to him. Thus in a certain case, the crop was sold for 4,000 rupees in February 1913, but owing to the subsequent glut in the market the contractor could not realise more than 3,000 rupees and a little over and paid the owner 200 rupees less than they agreed on. In another place, a certain gentleman's crop was sold one year for 1,000 rupees but it was unlikely that the merchant would realise more than 600 rupees, as the crop was very much damaged by untimely rains in the month of February.

Generally the crop is sold to fruit merchants or to contractors, but very often it is sold to village people who in turn sell it to fruit merchants through middlemen. Thus, where the plantation is large the crop passes through a great number of hands before it actually comes into the hands of the customers, the middlemen always getting the lion's share, with the smaller risks.

Where the plantation is small and the number of plants below three hundred, the disposal of the fruits can be done without the intervention of the middlemen and the fruit can be sent direct to the very door of the customers, thus making the fruits available to the latter at cheap rates. This system has the following advantages :—

(1) It brings more money into the pockets of growers.

(2) It does away with that class of middlemen by whose intervention the fruits reach the customer at dear rates.

This system, however, becomes unmanageable for a grower who owns large plantations and is thus led to have recourse to the system of selling through middlemen.

Apart from the risks previously mentioned it will be profitable to purchase the whole of a plantation in advance, if the purchaser considers the following points before making a venture :—

(1) *Proximity to railway stations and to well-known markets.*—In the district of Thana, the plantations containing grafted plants near the railway stations such as Thana, Kurla, Bandra, Andheri, Goregaon, Borivli and so on, yield immense profit, the valuation of each bearing plant ranging from 4 to 6 rupees. To cite an instance, a certain land-owner in this area possessed more than 1,000 plants. Of these half the number of trees were Pairis, one-fourth Alphonse and the rest of different varieties such as Batlli, Roos, Salghat, and others. His crop fetched as follows :—

Year.		Amount in rupees for which the crop was sold.
1908	..	1,150
1909	..	2,100
1910	..	1,800
1911	..	1,500
1912	..	3,400
1913	..	3,800
1914	..	4,000

In another gentleman's garden in the same area there were nearly 800 trees and in 1914, he realised 5,000 rupees, the age of the plants varying from 6 to 20 years. In places far away from railway stations and the markets where, as a consequence, the facilities for marketing and easy transport are small, the value of the crop is very much lowered and the fruit of each grafted plant fetches from eight annas to one rupee. In such cases the expenses of cartage add greatly to the cost of production and the fruits deteriorate on account of the long cart journey.

(2) *The age and bearing capacity of the trees.*—The grafted mango begins to yield fruits from the 5th to the 6th year of its life but the prolific years are ordinarily its 10th to its 35th year. Thereafter its yield gradually declines. Age also greatly influences the power of the fruits to remain on the trees. If the plant is in full vigour, the losses caused by windfalls are considerably less than in old trees whose exhausted vigour is not sufficient to enable them to withstand the effects of heavy winds or storms. These often come with so terrific suddenness as to cause complete

failure of the crop. Consideration should, therefore, be given to the age of the trees.

(3) *Early or late bearing.*—In Bombay and in the neighbourhood of Ratnagiri, the mango harvest is nearly over by the end of May, except for a few late varieties ; whereas in Poona and the neighbouring district it begins from the middle of May and continues till the end of June. Where the mangoes are sold late, especially after the rains have set in, the demand for them is very small, and as a consequence they have to be sold very cheap. The time of bearing will therefore have to be borne in mind.

(4) *The behaviour in bearing of some old country trees.*—In some places, there are old country trees reputed either for immense bearing capacity every year or for their delicious fruits, which often approach the Alphonse in quality. Such trees fetch a very great sum annually or biennially and thus enhance the value of the crop. For example, in Kalamsara (Taluka Pachora, District Jalgaon) an old country tree, Borsha by name, fetched 700 rupees in the year 1914.

(5) *Bearing out of season.*—Fruits out of season being rare are sold very dear and go a great way in increasing the value of such a tree. Thus in Trombay, one single Alphonse tree fetched 120 rupees in the month of December 1908.

(6) *The number of Alphonse or other trees of good quality.*—The Alphonse variety is the mango *par excellence* and the valuation of the plantation is generally based on the extent of ground under this variety.

(7) *Lean or fat years for the mango.*—As a rule, the mango bears its crop in alternate years. The abundance of one year is generally succeeded by a small crop next year and though conditions that determine this are difficult of explanation, yet, from a commercial standpoint, they influence greatly the mango trade. The purchaser should take these things into consideration as, when markets are glutted with mangoes, the value of the crop will be lowered. The scarcity or abundance of the mango is not the same in all parts of the Province. The lean year for the mango in one part, for instance, the Konkan, may be a fat year for the Deccan and *vice versa*. These considerations therefore are of great weight in the estimation of the mango crop.

(8) *Climatic conditions such as prevalence of clouds, untimely rain, heavy storms, etc.*—This factor is the most important that is to be considered and is one that causes the failure of the crop. Clouds during the flowering time do a great deal of damage by causing the flowers to drop off. Woodrow[1] says " If the hot cloudy weather which accompanies the thunder-storm and turns milk sour occurs while the trees are in blossom, the flowers mostly fall off without fertilisation and in consequence the crop is scanty." The same effect is caused by the rains at the flowering time. It profoundly affects the fecundity of the flowers. Such a condition occurred in the month of February 1915, near Bombay, and the violent untimely rain washed away much of the pollen and greatly reduced the crop. Again, the usually heavy storms, that blow during April and May, cause a considerable drop in the number of fruits left on the tree and the purchaser is put to a great loss. Allowances for these must be made by the purchaser.

Besides, the availability of labour and the prevalence of insect pests such as Jassids and fruit-flies are points which should be taken into consideration as they greatly affect the crop.

There is little doubt that if co-operation in selling were introduced, mango growers would obtain larger prices for their fruits. At present the middleman has it all his own way.

Foreign Markets.—In 1913, an enquiry was made with four shipping companies in Bombay as to the number of mangoes exported per season. The 1913 exports of the four companies totalled 1,470 dozen mangoes. This is a much larger number than one would expect and one wonders where all the fruits went to. The fruits are said to be exported in small wooden ventilated partitioned boxes holding one fruit per compartment.

Messrs. George Monro, Limited, Covent Garden Market, London, in 1914 wrote as follows :—

" We receive occasional consignments of mangoes generally sent to us by business people who have brought them from Bombay. We have also had several instances of traders who have endeavoured to send large quantities but they have never arrived in good condition except when they have come in small lots brought personally. I should not have thought that there were as many as the letter states coming

(1) Woodrow : The Mango.

to England regularly but should imagine that most of them are sent to friends as I have never heard of any quantity of them being in the trade and should not think it possible that a hundred cases were received for sale at the outside. There is a demand for really fine mangoes from Bombay if they arrive in good condition, but the difficulty of getting suitable temperatures has always been in the way of this with any larger quantity, and you can realise that this fruit like peaches, unless A1, are of very little value on the market."

The British Consul in Brindisi wrote in 1914 :—

> "There is no commercial import (of mangoes) here. In the first instance they would arrive during the Italian fruit season, when native fruit is cheap and abundant. Secondly, the Brindisi Port Said P. & O. packets have no cold storage except for stores and the mangoes are only taken as a favour to their own officials. There is no doubt that mangoes will arrive in good condition, if properly packed, but there is no sale for them here or elsewhere in Italy."

The experimental shipments of fruits to Europe from the Ganeshkhind Botanical Gardens are mentioned on page 44.

It appears, therefore, that (1) the European market is at present limited ; (2) until cold storage is provided for mangoes on the Europe-bound steamers the fruit will not arrive in good condition.

Both Higgins and Wester state that fruit has been satisfactorily sent from the West Indies and from India to Europe. As has been seen by the trials at the Ganeshkhind Botanical Gardens the possibility of Indian shipments arriving in good condition is small. Wester states that in Florida the Tomato-crate is used for shipping mangoes and appears to answer well. All writers agree that thorough ventilation is necessary to prevent fruits from going bad *en route*, and that each fruit should be wrapped in soft tissue paper.

CHAPTER VI.

The Transport of Trees, Scions and Seeds.

Packing of Grafted Mango Trees for Transport.—Mango plants may be packed with or without pots. If the grafts are not to be immediately planted out on arrival they may be sent in pots, but the pots give extra weight to the package and some at any rate are certain to be broken *en route*. The roots in such broken pots are exposed and the plants may die.

If the plants are required for immediate planting they should be taken out of their pots or the pots should be broken off from them and the ball of earth tied up in sacking. The balls thus tied should be immersed in water and the plants then put in the packing case. If the case is to travel a long distance, then the space between the plants should be filled with dry grass or moss. Ordinary deal wood packing cases are suitable. A consignment of few small grafts may be sent in a basket but as the parcels are apt to be roughly handled on the railway, boxes are best. The following is a convenient size of a box :—

Length 2′ 6″ × breadth 1′ 9″ × depth 1′ 6″.

This holds from 12 to 18 grafts according to their size and age. The lid may be dispensed with and the top covered with sacking.

The plants can project above the level of the box without harm. Two rope handles should be fixed on to the box.

Plants can be sent in this way even in the hot weather. In April 1916, a consignment was sent from Poona to Jamesabad in Sind and arrived in good condition, and another to Gorakpur in the United Provinces equally successfully.

It is essential that the plants to be sent should be well hardened, straight-stemmed plants with buds in a dormant condition. If the plants are in flush, there is likelihood of the new growth dying and possibly the plants also.

Packing for Foreign Countries.—Woodrow[1] recommends the use of Wardian cases. These are essentially boxes with a glass roof protected by strips of wood. Ventilation takes place through sheets of pierced zinc, and boxes are raised from the ground on square wooden legs. These cases are always expensive and hold few plants in proportion to the material used.

Ordinary deal wood packing cases have been used at the Ganeshkhind Botanical Gardens for despatch of plants to Washington (United States of America), Dongola, and Cairo (Egypt). Twenty-seven out of twenty-eight plants arrived in good condition at Washington ; fifty plants were sent to Dongola and were acknowledged. No report of damage was made. Out of a hundred sent to Cairo fifty-eight arrived. Those not in good condition on arrival were not all dead from physiological causes but one case had been roughly handled and many

(1) The Mango, pp. 21-22.

plants broken. To give an idea of the bulk of these consignments the following figures of the Dongola consignments are quoted :—

	Dongola. No. of grafts.	Weights.	Sizes.
Package I	18	210 lbs.	43" × 24" × 28½"
„ II	20	213 „	43" × 24" × 28½"
„ III	12	142 „	33" × 22" × 28½"

Cost—

	Rs. a. p.
50 Alphonse mango grafts at Rs. 1-8-0 each	75 0 0
Packing charges	50 0 0
Railway charges from Kirkee to Bombay	4 10 0
Shipping charges	96 9 0
Total ..	226 3 0

In the annual report of the Hawaii Experiment Station for 1908, page 47, an account is given of shipping mango rafts to Washington by Mail Steamer. As far as moisture at the roots was concerned the plants arrived in good condition but the immature wood died and the plants became defoliated either during the journey or on arrival. The packing only of plants with mature wood and dormant buds is recommended.

Experience at Ganeshkhind Botanical Gardens shows that the plants must be small, hardy and dormant with no diseased or weakly branches. On the way ventilation and watering must be arranged for. Both can be secured by fixing wire netting over the top end of the box and nailing over it strips of wood at intervals of two inches, instead of putting on a lid. The cases should be kept on the deck of the steamer out of the way of sea water and tied in position. They should be watered lightly with fresh water through the top of the case every second day in hot weather.

Packing Seeds of the Mango.—Our present experience gives no definite guidance as to the best methods of packing seeds. Seeds received by us from the Philippines packed in moist saw dust had mostly germinated *en route*. Of the germinated seeds few lived after planting and the other seeds did not germinate. Seeds received from the same source packed in dry charcoal had not germinated on the way, but a very small percentage germinated. This may have been due to the fact that the seeds had been about three weeks on the way. As has already been shown (page III) the mango seed rapidly loses its germinating capacity after a month. Consignments of seeds to Cairo and to Livingstonia have been sent. These seeds were packed in

charcoal. On account of delay *en route* and delay in opening the parcel in others, the seeds did not germinate.

Packing of Mango Scions.—The packing of scions for transport to other countries by post has received attention by us and by the Department of Agriculture, United States of America. The following report was received on some scions sent to Hawaii: "I regret to have to report that we got no result whatever from the cuttings which you so kindly sent twice. We very carefully budded them and grafted them but whether it was due to the climate or some other cause none of them would start. Quite a number of each variety sent at those two times were dried and dead but we tried all the green ones in the best way we could but, as I have said, got no results."

Wester[1] says "in the shipment of scions or budwoods these should be selected from straight growths of well-matured wood, somewhat larger in diameter than a lead pencil and from which all leaves have dropped and all leaf-scars are well healed." He recommends that the scions be packed in moist sawdust and wrapped in wax or oiled paper and finally in Manila paper or in tin tubes without paper.

No mention is made of success or failure of scions thus packed. In 1914, we received four scions of the Oahu mango from Hawaii. These were packed in moist sawdust covered with oil paper and packed in a tin tube. Two were completely rotten and two half-rotten on arrival. We budded four and crown-grafted one. None of these took.

"It[2] is stated that scions from India and elsewhere in the East usually arrive in the United States of America in an unsatisfactory condition. Messrs. Lathrop and Fairchild sent experimentally scions of the Jaffna mangoes from Colombo to America. The parcels were a month on the way. These were tin tubes packed in various ways. The most successful method was to cover the cut ends of the sticks with collodion and dip the whole stalks in mud. These were packed with a small amount of moist coir. Their condition on arrival is described as fairly good. The scions were comparatively young. The writers of the Bulletin state that older wood could also probably be sent.

Again, no information was given as to whether the scions were used for grafting or budding and with what success.

(1) The Mango, p. 38.

(2) U.S.A. Dept. Bull. No. 46 (Bureau of Plant Industry), p. 14.

To sum up : while scions are cheaper to send than plants, it is seldom that they arrive in good condition. Seeds keep their vitality only a short time, and the resulting plant may not come true to type. We are thus forced to conclude that the only satisfactory way of importing mango varieties is to have small hardy grafted plants sent.

CHAPTER VII.

Unsatisfactory Plantations.

Renovation of Neglected Plantations.—Mango trees are often left to take care of themselves after they begin to bear, the idea being prevalent that they require no treatment except the picking of the fruits. The evil effects of this are easily visible. Many buds make feeble growth, others rot and fail to develop. The inflorescences are small and few fruits appear. The slender branches are weighed down by such fruits as are formed and do not regain their first position. The ground is hard and weedy on account of absence of cultivation. Light and circulation of air are at their minimum. Many branches are dead or dying and the trees present an unhealthy aspect. All the diseases creep in, viz., black-stem, red-rust, sooty-mould and lichen. Loranthus abounds and takes a firm hold of the trees. Such trees, unless taken in hand early by a man who knows his business, become irretrievably ruined. The methods to be adopted are tillage, manuring, pruning, spraying and general sanitation. No matter how thorough and complete such treatment may be, trees that have been neglected for several years will never bear the same crops as trees that have been properly cared for from the start and all the time.

The first necessary operation in renovating a plantation is the removal of all the branches that would interfere with ploughing. These branches should be taken off by a saw and the edges trimmed smooth with a sharp knife. The cut surface should be covered with tar. Where ploughing is absolutely out of the question because of the roots being too near the surface, hand digging must be done. If the trees, as is often the case, have been planted too closely, every alternate tree must be cut out so as to leave at least 30 feet from tree to tree in all directions. After these preliminary operations, dead and diseased branches should be cut off and then pruning for shape should be taken in hand. There may be some difficulty in deciding what branches to keep and what to prune off. It must be the aim of the pruner to give plenty of space to all the branches so as to encourage a plentiful

development of leaves to prevent the tree from becoming a mass of lanky branches with a few leaves at the top ends. In October 1911, in Ganeshkhind Botanical Gardens, twelve trees were thus pruned. In December 1911, five plants were in full new growth. In three trees a few branches were in growth and in two growth was beginning. In the unpruned area not a single tree was in growth. In January 1912, three completely pruned trees produced inflorescences in the top position while two from the other plot produced inflorescences. In April 11, 1912, seven of the pruned plants produced hot weather growths. In the unpruned plots nine produced these. In October 1912, the same trees were again pruned. Both they and the controls produced plenty of vegetative growths in February and March 1913. Ten pruned plants produced fruits, the total being 1,017. Of the non-pruned plants nine fruited, the total number of fruits being 1,022. The difference between the two sets is thus not perceptible. It is worthy of note that in two years the pruned plants made up leeway and became as prolific as the unpruned plants (Photo Nos. 11 and 12). In October 1913 the pruned trees were again pruned lightly ; only dead and crowded branches were pruned. Six produced fruits totalling 93. In non-pruned trees eleven fruited, producing 240 fruits. In other respects there was no appreciable difference.

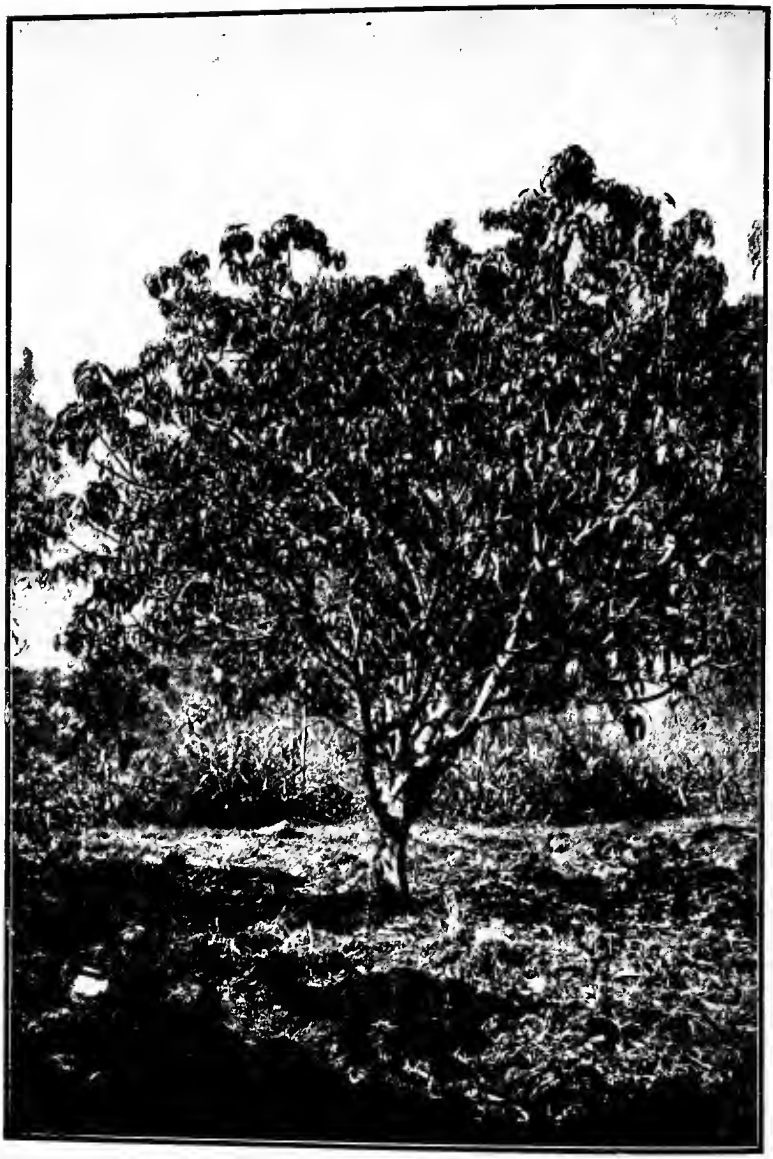
It must be admitted that this experiment does not show greatly in favour of pruning. On the other hand it clearly shows that if the trees receive a set-back by pruning they rapidly recover from it and bear as well as ever. As a matter of fact, the trees in question were not sufficiently neglected for the full benefit of the treatment to show and again it must be remembered that pruning in the case of the mango is not primarily a matter of pruning for fruit (since, as we have shown, inflorescences may occur on all growths), but a matter of pruning for shape and vigour. This can only be done satisfactorily by shaping the tree in its early non-bearing years and then leaving it alone except for the cutting out of a diseased or crowded branch now and again. It is the same story for every operation,—the only profitable plan is to treat the tree rightly from the start and all the time.

A plot of 33 Cowasji-Patel trees of 10-12 years old was chosen and treated thus. It was ploughed in August 1910 and dug wherever the plough would not go. This operation was repeated yearly between August and November. The control plot consisted of 37 trees of the same age and variety. There was no marked difference in flowering time between the two plots but there was a difference in

No. 11.

Pruned Pairi tree.

No. 12.



Unpruned Pairi tree.

healthiness and vigour and also in number of fruits borne. The numbers were as follows :—

Year.	Total of fruits. 33 trees of dug plot.	37 trees of undug plot.
1913 ..	1,217	423
1914 ..	1,246	724
1915 ..	1,069	548

The fruits were not counted in 1911 and 1912. This experiment was stopped in 1915 after the crop was taken. The experiment shows clearly the advantages of the cultivation of the soil. No manure was given during this period to either plot.

The removal of lichens and sooty-mould from branches can be done by scrubbing with coir rope or other rough material. Spraying for insects (Jassids) should be done a month before the inflorescences appear. For this purpose fish-oil-resin soap (1 : 60) is useful. A large sprayer mounted on wheels is required.

A look-out must be kept for trees affected with grubs of the boring beetle (see p. 45). Reinfection with Loranthus must be watched for and any small plants of this parasite carefully cut out and the wound tarred.

The important rule in the sanitation of a mango plantation (or for that matter any fruit plantation) is : *Never let the plants get into a bad condition.* To keep the plants in good condition is easy if *continuous personal attention* is given. On his daily round of the plantation the owner can prune a branch here, rub off a lichen there, supervise a piece of digging in another place and see to spraying. Left to itself or to the tender mercies of the labourer or a contractor, no plantation will thrive.

Sterility.—By this term we mean that the tree does not bear fruits. The following cases can be distinguished :—

(1) Trees bear flowers but fail to set fruit.

(2) Trees refuse to flower although of an age to do so.

(3) Trees flower and fruit in alternate years only.

Let us study type (1) more closely. This kind of sterility may be due to a variety of causes, one of which is the condition of weather when the flowers are opening. Rain, fog, excessive cloud and hot winds all affect the flowers. The moisture of the rain and fog probably washes away the pollen. The effect of hot winds is simply over-heating and drying of the delicate flower tissues. The action

of clouds is doubtful but the following are guesses. Radiation of terrestrial heat is checked and a close damp hot atmosphere results. This may be directly detrimental to the cells of the reproductive organs, or it may possibly induce the formation of enzymes that are detrimental to the cells of the plant. It is also possible that there is some connection between cloudy weather and the breeding of Jassids and also between the amount of enzyme in the tissues and the greed with which the Jassids suck them. Such cloudy weather often comes suddenly. It is difficult to devise means to combat it. Woodrow[1] suggests flooding the ground of the plantation with water as soon as the gathering clouds are observed.

Another cause of sterility is the attack of insects such as Jassids. These insects, when they appear, attack the inflorescence in such large numbers and suck so much sap that flowers fail to set fruit. Such cases very often occur in Sind. Their life history, general description and remedies are given on p. 66.

It is also possible that a given tree may be what is called a "shy bearer," i.e., its natural peculiarity is to set little or no fruit. In this case the difficulty can be overcome by side or crown grafting or top-working the tree with scions of a good prolific variety.

We have at present no data as to the effects of manuring on sterility nor is there any information as yet regarding self-sterility (if it exists) among mango varieties.

Failure to bear in Alternate Years.—It is a belief among Indian mango growers that the tree bears a heavy crop only every alternate year and that in the intervening years the crop is poor. Our experience in Ganeshkhind Botanical Gardens on the whole confirms this.

The following is the crop record from 1908—1916 :—

Year.	Crop.
1908	.. Good.
1909	.. Poor.
1910	.. Fair.
1911	.. Fair although frost spoiled many flowers.
1912	.. Poor.
1913	.. Exceptionally good.
1914	.. Poor.
1915	.. Good.
1916	.. Fair.

(1) Gardening in the Tropics, Edn. VI, p. 257.

This peculiarity of the tree is taken into account by those who speculate in the mango crop. The probable cause is connected with the nutrition of the tree. Heavy fruiting undoubtedly takes it out of a tree and the plant has to recover from its effects before producing another heavy crop. It may well be asked : " Why cannot the trees recover between one season and another ? " The answer is that the fruit remains on the tree till, say, June, and the next flowering comes in the following January, so, there is little enough time for recuperation. It is naturally suggested that heavy manuring would to some extent assist the tree to recover more quickly. This remains to be tried.

Hartless[1] suggests the removal of the flowers of certain trees in a plantation so as always to have some in bearing. But he does not say that he has tried this. He also suggests thinning the crop and thinning out the shoots of the growing year.

CHAPTER VIII.

Flowering and Pollination.

Time of Flowering.—In the neighbourhood of Poona, inflorescences begin to appear annually about the first week of December. In Trombay, on the coast near Bombay, they appear as a rule about the end of November. In Ratnagiri, on the coast further south, they are quite as early. Mango fruits from Madras come into the market practically all the year round, which means an equally extended flowering season. There is a variety of mango termed Baramashi—the twelve-month—signifying its characteristic of flowering. The main flowering season, however, is round about the beginning of the year. This is the time observed also in the United States of America and the Philippines.

On January 23, 1913, the Acting Explorer in charge, United States Department of Agriculture, wrote us as follows :—

> " The period at which the mango flowers in Florida, varies more or less with the seasonal conditions. This year a few trees were in bloom in December. However, under normal conditions the first blooms appear sometime in January, the last sometime in March. Very often, there is a second flowering season in June. The mango appears to be erratic in regard to its time of blooming. A protracted drought followed by soaking rain or in fact anything that causes a severe check to the growth of the tree is apt to force it to bloom."

(1) Agri. Jourl. of India, Vol. IX, Part II, April 1914.

The Horticulturist, Bureau of Agriculture, Philippine Islands, wrote us on February 19, 1913, as follows :—

> " I take pleasure in informing you that the earliest varieties that I have seen come into flower late in December and early in January. I have not noted when the first flowers of late varieties appear. In Florida, I have never noticed untimely flowering of the mango, that is, any flowers coming later than early in May. In the Philippine Islands, however, it seems that very rarely the mango trees will burst into bloom suddenly almost any time of the year. This of course provides for a few mangoes during the better part of the year also. I have unfortunately not had the opportunity to note whether this habit of flowering at unusual times is a regular feature of such trees."

In the Bombay Presidency, besides the January flowering, one other well marked flowering time is sometimes observed. To this matter attention has been drawn by one of the ex-students of the Poona Agricultural College, Mr. K. V. Tamhankar,[1] B.Ag. He suggests a classification into (1) those trees that flower every alternate year, (2) those that flower every year, (3) those that flower in September-October or both in January and September-October. His first class is based on the belief that in each alternate year the crop is small. The September flowering is not entirely conditioned by variety. In September 1912, an unusually large number of mango trees in various parts of the Presidency produced flowers. The climate of the previous months was as follows :—

Rains, 1911. Poor rains with a great burst in October-November.

Cold weather, 1911-12. Normal : Mango flowering poor.

Hot weather, 1912. Very hot and dry.

Rains, 1912. Rains delayed, they burst at the end of July, then a break, then again heavy rains in August.

We have here conditions similar to those cited in a letter from the United States Agricultural Explorer, namely, poor flowering previously, considerable check by heat, and then sudden moisture in excess.

One tree in the Bassein Taluka of the Thana District blossomed in the first week of September 1911 and produced fruits in November. It was a seedling tree. This tree is said to blossom every year at this time.

(1) A note in the Agricultural Journal of India, Vol. VII, Part IV, pp. 399-402.

Near Dharwar, in 1911, we saw a mango tree flowering in September. It had never before been known to flower at that time of the year.

In a garden at Trombay, many inflorescences appeared in September 1912, and fruits formed. Quite close to them new inflorescences, both terminal and axillary, occurred in January 1913. Similar cases occurred in Ganeshkhind Gardens. In the same Trombay garden it was remarkable to see that many individual Pairi and Alphonse trees went on flowering from the beginning of December till the end of February 1913. On the same tree all stages from unopened flowerbuds to fruits of the size of a pea were observed. The owner of the garden stated that the flowering sometimes went on till the end of March. Fruits are thus available in this plantation from the end of March till the end of June.

Inflorescences may be formed even as late as April and that too in close proximity to fruiting inflorescences.

That this phenomena of the double flowering season is not confined to India, is shown by the following extract[1] :—

" The season of the flowering of the mango in Honolulu has been noted with interest for several years. A record has been kept of the first flowers observed which appeared to be the beginning of a general blooming season, disregarding the few flowers that may appear almost at any time. The record of the beginning of the season has been as follows :—

January 1 to 10, 1906 ; December 10 to 12, 1906 ; November 15 to 20, 1907 ; and February 15 to 25, 1908. Attention is called to the fact that for three successive years each season of flowering has been nearly one month earlier than in the preceding year. For the mango crop of 1908 there were two seasons of quite general blooming among the mango trees of Honolulu, the first being in November and the second in February. It will be observed that a period of three months is thus covered which is a marked contrast to the seasons of flowering where climatic conditions are more sharply defined."

In the Deccan the pomegranate, guava, and all the citrus species have three flowering seasons termed in Marathi *bahars*. These are the *Ambe-bahar* (January), the *Mrig-bahar* (June), and the *Hatti-bahar* (September). Trees can be forced to flower at any one of these seasons by stopping water for some time and exposing the roots of

(1) Annual Report of the Hawaii Agri. Expt. Stn. 1909, p. 47.

the trees, at the same time pruning off a few of the smaller roots. Such a treatment was given to some mango trees in 1911 and 1913.

On the 13th and 14th December 1912, twenty-three trees in Ganeshkhind Botanical Gardens had their roots exposed. Between December 25 and 29, 160 lbs. of farmyard manure were given to each rested plant. Twenty-one similar plants were observed as controls. Results :—

Rested trees.	Non-rested trees.
7 flowered on January 8, 1913	7 flowered on January 8, 1913
1 „ 11, 1913	4 „ 29 1913
9 „ 29	
17 flowered	11 flowered

On October 24, 1913, five plants had their roots exposed and pruned. Manure was given at the rate of 80 lbs. per tree on November 15, and watered immediately after. Five control trees were observed. Results :—

Rested trees.	Non-rested trees.
1 flowered on January 15, 1914	2 flowered on February 1, 1914
2 „ February 1, 1914	1 „ „ 5, 1914
1 „ „ 20, 1914	1 „ „ 10, 1914
1 did not flower	1 did not flower
4 flowered	4 flowered

The above experiments conclusively show that the exposure of the roots of the mango in the way practised on oranges and guavas has no definite effect on the time of flowering of the mango or on the number of trees that will flower.

Further attempts to force mango trees to flower were made also on the following lines :—

(2) Pruning the branches at different points.

(3) Planting grafts taken from trees reputed to bear at unusual times.

The method of pruning done for two years was as follows :—

(*a*) Pruning was done all over the tree, just behind the first bud scar.

(*b*) Pruning was done all over the tree, behind the second bud scar.

(c) The same behind the third bud scar.

(*d*) All the above three methods were used on different branches of one tree.

The results were that a great many vegetative growths burst forth near the pruned places, more so in the (*a*) method than in others, and where inflorescences were formed they were stunted and weakly.

The third line of experiment, viz., grafting trees of reputed unusual flowering season has not as yet given any conclusive evidence, since the plants have not borne flowers.

In the *Agricultural News* for October 1915, page 342, an account is given of a method said to be employed in the Philippines for forcing early flowers and fruits. This method is the smoking of the trees continuously for two months previous to flowering. To test the method two Alphonse and two Pairi trees in Ganeshkhind Botanical Gardens were continuously smoked from December 25th, 1915, to the middle of March 1916. The smoke was produced by burning rubbish and cow-dung cake at the foot of the tree and the smoke was passed through an earthenware pipe to direct it among the branches. A six-foot wall of matting was also erected round the trunk to prevent the smoke spreading. There was no appreciable difference between the smoked trees and their controls as the year was a fat one for the mango.

In certain parts of the Bombay Presidency and in Alibag District particularly, a form of Ringing or the removal of a circular ring of bark, two inches in thickness all round the stem, is adopted with the object of hastening flowering or rendering unfruitful trees productive. Macmillan[1] mentions this method for forcing flowers.

Experimental evidence in this direction is, however, wanting, but the operation has the disadvantage of wounding a branch severely and if performed extensively upon a tree it is apt, if not to kill it, at least to render it incurably unhealthy ; for, if the rings are not sufficiently wide to cut off all communication between the upper and lower lips of the wound they produce little effect, and if they are wide they are difficult to heal. For these reasons, the operation is undesirable.

Pollination.—The following are our own observations and conclusions :—

The flower is undoubtedly entomophilous and designed for short-tongued insect visitors. Honey is secreted in considerable quantity

(1) Handbook of Tropical Gardening and Planting, Ed. II, 1914, p. 82.

from the disc and there is a peculiar odour the source of which is as yet undetermined. The honey is often spread all over the inner surface of the petals showing that secretion begins before the flower opens. Flies belonging to the general *Psychonosma* and *Pyrellia* are the chief visitors in Poona, and a tree in full flower fairly hums with them. Ants crawl over the flower and steal the honey, but it is doubtful how far they assist pollination.

Self-pollination is possible.—In many cases the present writers have noticed flowers with the stigma and the anther very close together or actually in contact. This is not by any means the rule. The anther and stigma generally stick out away from each other in the opened flower. In some of the cases where the contact of anther and stigma was observed pollen grains had been deposited on the stigma and style. In 1911 inflorescences of Cowasji-Patel trees were enclosed in paper bags during the whole development of the inflorescences. Several fruits set in the bags showing that pollination of some kind had taken place without the intervention of the insects.

The hermaphrodite flowers are protogynous.—The flowers open and remain open some time with the nectary actively secreting and the stigma fully exposed before the anther bursts. In several cases we have seen this condition of the flower with the pollen grains on the stigma and in one case the stigma withering and the ovary fertilised, though the anther of that particular flower was yet unburst.

There are no scientific data as to whether crossing between varieties takes place or not. It is believed in this part of India that one can never be sure of the produce of a seedling mango even though it is raised from the fruit of a first class variety. It is assumed that this is due to crossing with inferior varieties.

During 1911, 1912, 1913 we did a great number of crossings between varieties, using various methods. The first employed was that described in Bulletin 167, Bureau of Plant Industry, United States of America, Department of Agriculture, " New methods in Plant-breeding " by Oliver. In this method one cleans the pollen out of the flower by a fine jet of water instead of mutilating the bud by emasculation with scissors. Later in 1913-14 the anther was removed by forceps in emasculation. The following are the results :—

1911.—One hundred and forty-two crosses made between different varieties. The severe frost of 1911 February wrecked this experment. Thirty-three crosses set but none finally survived.

A crossed mango fruit.
Cross between Cowasji Patel and Pairi,
(female parent being Cowasji Patel).

No. 14.

An abnormal Mango inflorescence.

1912.—Inflorescences were few, so crossing was on a smaller scale, only seventeen being done. Three of these produced fruit of 25 mm. diameter each. These all later on dropped off.

1913.—One hundred and twenty-nine flowers were crossed in February 1913. Of these, 15 developed fruits of the size of a millet grain, but these dropped.

1914.—Two hundred and six crosses in all were made of these twenty sets. Sixteen reached the size of a millet grain and four the size of a pea. All finally dropped except one.

In February 1915 one hundred and fifty-three crosses were done. Of these, three of Cowasji-Patel and Pairi (the female parent being Cowasji-Patel) succeeded. The seedling of one of these has been transferred to a plant in the field. Photo No. 13 shows the crossed fruit. The hybrid nature of the fruit could be seen by—

(1) The fact that the right shoulder is higher than the left.

(2) The smoothness of the skin (Cowasji-Patel fruit being rough and warty).

(3) The absence of the side sinus.

(4) Slight presence of the beak.

The fruit produced by the next generation will be awaited with interest as it may give a lead in determining which of the present forms are hybrid, and a hint as to their parentage.

CHAPTER IX.

Pests and Diseases.

(In consultation with Mr. Ramrao Kasargode, L.Ag., Assistant Professor of Entomology, Agricultural College, Poona.)

Insect Pests of the Mango.—Mango trees from the youngest seedling to even the oldest trees are subject to the attacks of various kinds of insects. Very few people recognise the importance of these pests and in a large number of cases the trees die before any attempt is made to find out the real cause of the malady. Especially is it so, when there are borers inside the stems or at the roots.

The young plants in the nursery, grafted or ungrafted, are equally attacked by certain kinds of leaf-eating caterpillars. Jagged and uneven edges of leaves are sure signs of the presence of these caterpillars and a careful search will reveal them either on the leaves themselves or closely sticking to the stems. One such defoliating caterpillar

is *Parasa lipida* (Fig. A). It is green like a leaf with two brown stripes along the sides and with irritating spines at both ends of the body. A much larger caterpillar but less often found and not so destructive is that of *Natada velutina* Koll. Brown tough cocoons of about the size of grapes are found plentifully sticking to the bark of the tree. From these the moths will emerge, giving rise to a new brood next season about the beginning of the monsoon. There seems to be only one generation of these in a year. *Parasa lipida* has been bred from a variety of plants besides the mango. It has been bred from *Terminalia catappa*, *Butea frondosa*, castor, tea, etc. In young seedlings as well as old, the pests can be easily checked by spraying the plants with lead arsenate. The hard tough cocoons can easily be found on the bark and must be destroyed to prevent future infection. The insects do very little damage to the old trees where there is a large amount of leaf but they are a source of constant danger to young grafts and seedlings which they often completely defoliate.

Another beautiful caterpillar found upon the mango leaves is that of a butterfly *Euthalia garuda* Mo. It is found sitting upon the middle of the leaf and, though it is a large caterpillar, cannot easily be distinguished from the leaf which it imitates closely. It is often found in considerable numbers on old as well as young trees. The pupa can be found hanging from the under sides of the leaves. In a nursery of young plants it proves troublesome and unless picked out constantly, it may not leave a single entire leaf. The radiating feathery projections from the body, together with the close resemblance to the structure of the leaf, hide the caterpillar effectively; but it can be tracked from the eaten leaves as it is found not very far away from them.

Another very important caterpillar is that of *Macalla moncusalis*. A number of caterpillars are found to bind the leaves at the end of a branch into a close nest-like formation inside which they feed. (Photo No. 17). The webs look much like red-ant nests from a distance but can easily be distinguished from a number of dry and eaten leaves composing the nest. The caterpillars are extremely active and slip down to the soil if the nest is torn. They are brown caterpillars with grey lateral stripes. Though these nests are found on larger trees they seem to do little damage, but young grafts are spoiled in appearance and vigour even though there are only a few such nests. Wherever they are found, they should be cut and dropped into a bag and afterwards destroyed by fire. Spraying the young plants with lead arsenate has been found to do considerable good. These pests appear about the middle of the monsoon and are found even in the hot

No. 15.

Appearance of a Mango tree attacked by a borer. (Batocera rubra.)

weather. There are a few other caterpillars found on the leaves but as they do occur in any large numbers they need little attention. One of these is found on very tender leaves and belongs to a moth *Bomboteilla Jacosatrix*. A hairy caterpillar *Euproctis scintillans* with clumps of velvety hairs is also found on young plants but this, as well as others of less importance, need no special treatment as they are easily killed by the lead arsenate spray advised in the case of other caterpillars. A small weevil has been seen cutting the leaves right through the midrib and laying eggs in the cut portion. The cut portion drops to the ground below, the grub mines into the withering and decaying leaves entering the soil to pupate. One case in which this weevil played havoc with a newly established garden came to our notice in Poona. There was not a single green leaf on the plants. The best remedy is to burn all leaves that are found dropping to the ground to check future broods. They always appear in the latter half of the monsoon and are not found afterwards.

Another caterpillar appears about the same time or a little earlier and is found tunnelling the tender shoots. It is of a small moth *Clumetia transversa*. As often as new shoots are put forth the caterpillar is already tunnelling it and it is a very common sight in grafted plants to see dry twigs with holes in them. The damage is very great, checking the growth of plants during the monsoon when only new leaves and shoots are put forth. No remedy is likely to effect much except cutting off every such withering shoot and burning it. Very often a white weevil *Myllocerus maculosus* is found nibbling at the leaves of young plants. Coupled with its appearance a few of the green kind *Astycus lateralis* are also found. They do not cause any considerable damage but can easily be destroyed if they do so. A broad, light winnow is handy in this work. It should be held under the plants and a light tap given to the branches. The weevils drop into the winnow and can be destroyed easily.

The older and more established trees have pests of different kinds. Though most of the caterpillars already noted on leaves are found on older trees, they cause little or no inconvenience. An important pest on old trees is a thick-set grub of a large beetle *Batocera rubra* and it is found boring inside the thick bark and stems also. The eggs are laid in the chinks of the rough bark and the young grub at first lives in the bark. When it gets older it transfers its attention to the wood inside. It tunnels up and down or may trace a spiral round the trunk. (Photos Nos. 15 and 16.) The latter is usually the way it mines the trunk when it confines its attention to the bark only. Tapping the

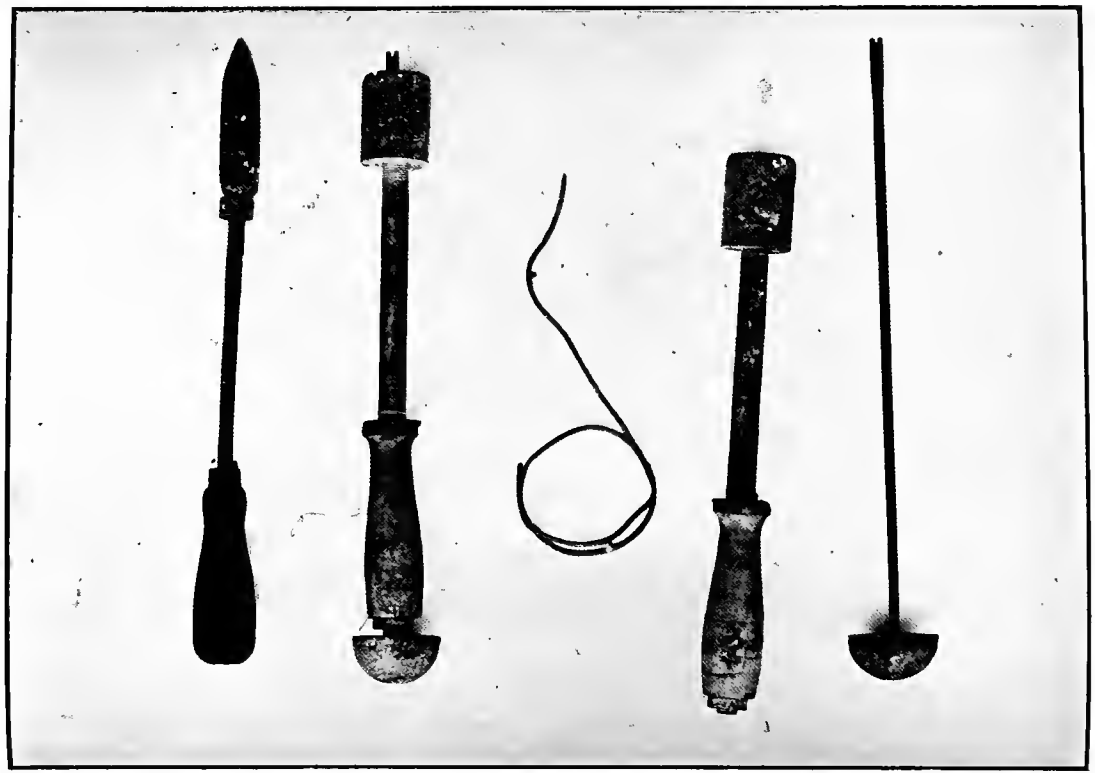
bark with a piece of wood reveals this damage by the hollow sound it emits, and the grub can be traced to the end of the gallery by this means only if the damage is recognised early. The chewed fibres can be seen thrust out from a crack in the bark and very often small heaps of this sawdust-like material can be seen collected at the bottom of the trunk. The grub can be scooped out with a stout penknife with little injury to the stem. The part may then be painted with tar so as to prevent other beetles coming and laying eggs in the tender parts. As many as a dozen can be pulled out of badly attacked trees. Where the grub has already entered the wood, half a tea-spoonful of a mixture of three parts of chloroform and one part of creosote may be injected into the hole by a syringe and the hole plugged. If the gallery is not crooked, a stiff piece of wire may be thrust into the hole till it reaches the grub and the grub killed in its gallery. In old dead trees the pupæ of this beetle are found along with the large flat grubs. Such trees must be destroyed to prevent the pest breeding unhindered.

At the flowering time small insects (*Jassids*) appear on the flowering shoots. They are sucking bugs, *Idiocerus clypialis*, and crowd round the flowers and young fruits, puncturing the tissues and sucking the sap. In consequence, the flowers as well as young fruits drop before they attain maturity. When the pest is bad, as in some parts of Sind, there may not be any fruits formed on the trees. The sweet secretion from these bugs is often so abundant that it may be heard dropping down on the leaves below. A black sort of fungus (*Capnodium*) grows upon this sweet secretion and where the pest is bad the upper surface of most leaves may be covered by this fungus, giving a black sooty look to the whole tree. This *Capnodium* is said to interfere with the respiration of the tree. A succession of broods may take place during the whole of the fruiting season and seriously affect the yield in fruits. Experiments conducted elsewhere have given a remedy by which a great deal of the damage can be averted and it consists in spraying the trees with crude oil emulsion at intervals of a week until the fruits have set. Experiments conducted at Ganeshkhind Botanical Gardens have not, however, been successful. The best remedy recommended is fish-oil-resin soap (1 to 60). To be useful the sprayings must begin a week before the trees flower and be continued until the mangoes are about the size of a marble.

Another pest of some importance on the fruit is a weevil *Cryptorhyncus mangiferæ*. This weevil lays eggs in the still undeveloped ovary of the fruit and the beetle passes through all the stages of growth inside the stone. When the fruit is ripe and ready for the table it

No. 17.

A webbing formed by caterpillars of Macalla moncusalis.



Soldering apparatus.

may chance to burrow its way out, giving the fruit an unsightly appearance. Discolouration of the pulp due to the excreta being thrust out of the stone is very often seen when such mangoes are cut. It is not every tree that gets attacked, but some trees have the reputation of being attacked every year while neighbouring trees may escape. There does not seem to be any remedy except to burn all stones irrespective of whether they contain the weevil or not.

A fruit-fly, *Dacus zonatus*, breeds profusely in the fruits. The fruits rot and 10 to 30 per cent. of the fruits are destroyed. The flies lay their eggs in fruits ready for picking and the larvæ (maggots) develop inside in the pulp, reducing the whole to a slimy rotting condition. The maggots, when ready to pupate, force their way out of the fruit and enter the soil. The best means yet found to stop the attack is to burn or bury all the fruits found to be attacked, so that the flies may not get any chance of breeding through another generation. Another means found so far successful is to keep windfalls, etc., as traps under the trees just a week or two before the harvest. If these trap fruits are punctured by a blunt nail the waiting flies readily lay eggs in such fruits. These fruits may then be destroyed. An attempt to destroy males by using a distillate of *Ocimum sanctum* (tulsi) as a bait is being made but conclusive results are not yet to hand.

The red ant *Œcophylla smaragdina* often proves troublesome to people engaged in the harvesting of the fruits. These ants bite and crawl up the legs and hands. Their nests are found on the trees. These must first be cut off and destroyed before any attempt is made to climb the trees.

The following are some of the scale insects that affect the mango :—

Aspidiotus destructor Sign.—This occurs commonly where mango trees are grown and becomes a serious pest if not checked. They fully cover the tender young branches and leaves. The upper as well as the lower surfaces of leaves harbour the species. In gardens devoted to mango growing, individual trees only here and there are seriously affected while the remainder are hardly attacked at all. It has been recorded also by I. H. Burkill on mango trees at Nadiad[1], Gujarat. The best remedy is to spray the affected parts with rosin wash (see appendix).

(1) Memoirs of the Dept. of Agri., India, Entomological Series, Vol. II, No. 2.

Chionaspis dilatata Green.—There are few scale insects more common than this on mango and banyan trees in Poona, where it occurs on both the upper and lower surfaces of the leaves. The females are rarely found, and when found they are always on the lower surface. The insect is known on palms in Calcutta, but its occurrence in Western India has not previously been noted.

Leucaspis indica Marlatt.[1]—This scale occurs commonly on mango trees, but does not seem to have been noticed previously in India. It was first identified in America on mango saplings introduced from India. The scales are completely hidden under the black mould (called *black stem*) so common in connection with scale insects, but under this covering the scales completely encircle the tender branches. It may become a serious pest if not carefully watched.

Pulvinaria psidii Mask.—This pest, which is so common on guava (*Psidium guava*) and which forms a white felt, has been found also on the mango.. The pest is recognisable from a distance by these white specks and also from the black mould which covers the leaves and tender branches. The scale attacks the green parts but has not been found to be a serious pest.

Icerya seychellarum West.—This has been rarely found on the mango shoots. It has not been observed on any other plants in Western India. The remedy for all the above-mentioned pests is to spray with rosin wash.

Fungoid Diseases.—Mango plants growing under normal conditions are little affected by fungi, whereas such as are predisposed to infection by unsuitable soil, dampness, close planting, injury by accident or otherwise—in fact, in a weakened condition however brought about—are more liable to attack. Fortunately, in the Bombay Presidency, there are very few serious fungoid diseases that attack the mango. In the following notes only those that are commonly met with in the Bombay Deccan have been mentioned.

Sooty-mould (*Capnodium mangiferum* Cooke and Broome).—The fungus grows on the honey-dew secretions of plant lice (aphides) and forms a dense black covering on the affected parts, usually leaves. The injury is not due to parasitic action but is

(1) Journal of the Bombay National History Society, Vol. XXIII, No. 1, June 30, 1914, p. 135.

mechanical, by exclusion of light the fungus interferes with the action of the chlorophyll.

Remedial measures should have in view the destruction of the primary cause—the aphides. One of the most satisfactory remedies is believed to be fish-oil-resin soap.

Red Rust (*Cephaleuros virescens* Kunz).—Spots or cushions appear on leaves which show a star-like arrangement of parts brick-red in colour. This is not known to cause any serious damage so far. It has been fully described by one of us in the Agricultural College Magazine.[1]

Black Stem (*Rhinocladium corticolum* Massee).—This affects the branches and covers them with a felt-like black coating of hyphæ. The fungus is associated with a scale insect, *Leucaspis indica*. It is not parasitic and apparently does no harm beyond producing an unsightly appearance.

Blight (*Gloeosporium Mangiferum*).—This attacks leaves and opening blossoms. The leaves become spotted black and the blossoms turn black, dry up and fall. Young shoots are also affected. The disease can be controlled by applications of Bordeaux mixture.

Black Rot.—This affects the ripe fruit and is due to a species of *Lasiodiplodia*. Black spots first appear and extend all over the skin and cause rotting. A preventive spray with Bordeaux mixture or ammoniacal solution of copper carbonate will be found beneficial. The fruits may as well be steeped in formalin (1 oz. to 2 galls. of water) before storing for ripening.

Other Diseases of the Mango.

The abnormal inflorescences.—Two papers, one written by Dr. W. Burns and the other by both of us, were presented to the then existing Bombay Presidency Science Association in 1911 and 1912 respectively.

Photo No. 14 shows an abnormal inflorescence. The axes are shortened and thickened. The flowers are crowded, are long in opening, have often enlarged discs, and seldom set fruit. The abnormal inflorescence may persist long after the normal one has fallen off the tree and may finally become vegetative. So far, no cause of this malformation has been traced. It is, however, not due to either insect

(1) Vol. I, No. 1, September 1909, Burns, W.

or fungus. Inoculation of buds with juice from malformed inflorescences has given no definite results. The internal structure gives no clue.

CHAPTER X.

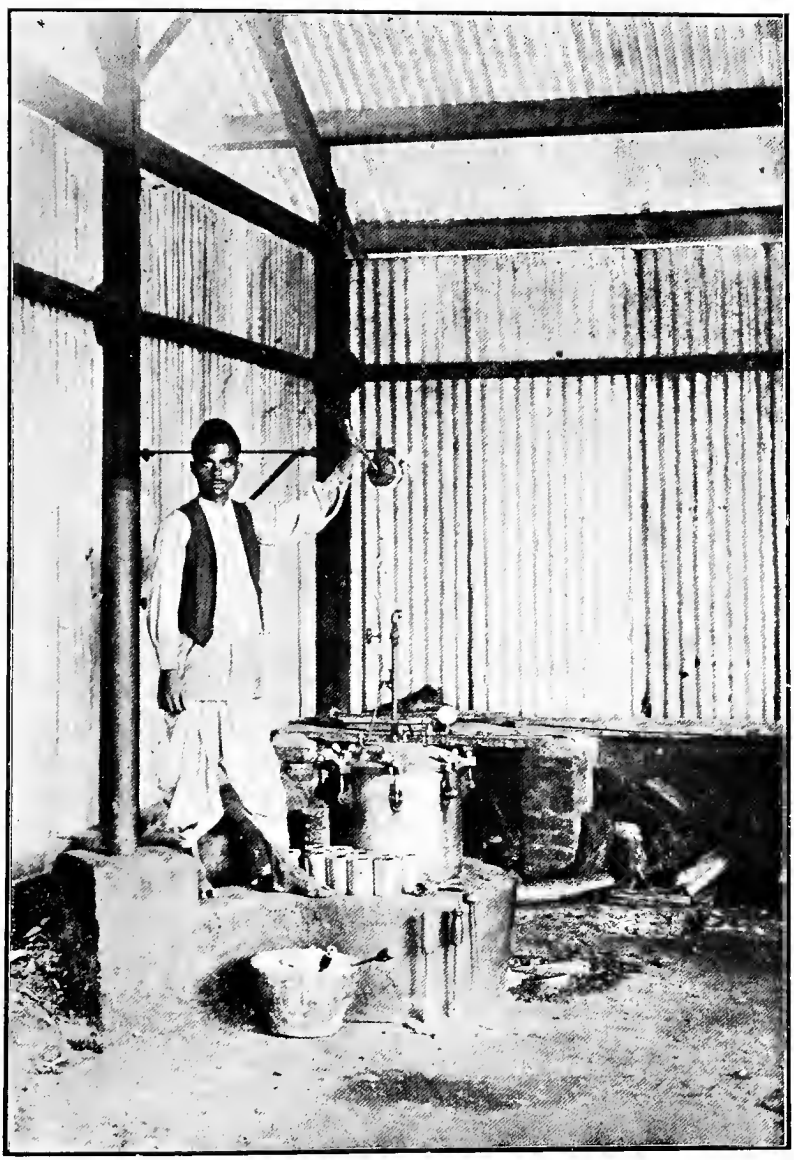
Uses and Canning.

Uses of the Mango.—The first and the most obvious use of the mango is as a food when ripe. Tastes differ as to the stage at which the fruit should be eaten. The European generally prefers it just as it is turning ripe, when the flesh is yet firm and cuts easily. The Indian likes it at a later stage when the flesh is soft and squashy. There are different methods of opening the mango for eating. One method common among Europeans is to take up a slice on each side leaving the stone and its surrounding pulp in the middle, scoop out the side slices and bite the flesh off the stone after removing ring of skin on it. The Indian often slices the mango into sections and eats each separately after skinning. A method practised in America is to remove a cap at one end and eat out all round the stone with a spoon.

Canning.—There is a possibility that a trade in canned mangoes may be developed. In certain coast districts many mangoes are left unsold yearly on account of the stoppage of steamers during the rains. A firm in Honavar on the coast of the Kanara District of the Bombay Presidency has for some years been producing excellent canned mango juice. Mango pulp preserved in syrup or honey is sold in the Bombay bazaar and a Bengal firm produced canned mango pulp for a time at least. Some Goanese firms also can in syrup. At present, there is no great demand in India or outside it for canned mango slices, but it is conceivable that a taste for this delicious fruit could be created. In the Ganeshkhind Botanical Gardens preliminary experiments in mango canning have been carried on since 1913. The apparatus used, was a steam pressure canning apparatus (Hotel Outfit No. 1) made by the North-Western Steel and Iron Works, Eau Claire, Wisconsin, United States of America. (See Photos 18, 19 and 20.) The net price of the apparatus was 50 dollars, *i.e.*, Rs. 156-4-0. This particular type of apparatus was chosen because it combined the following desirable characters :—

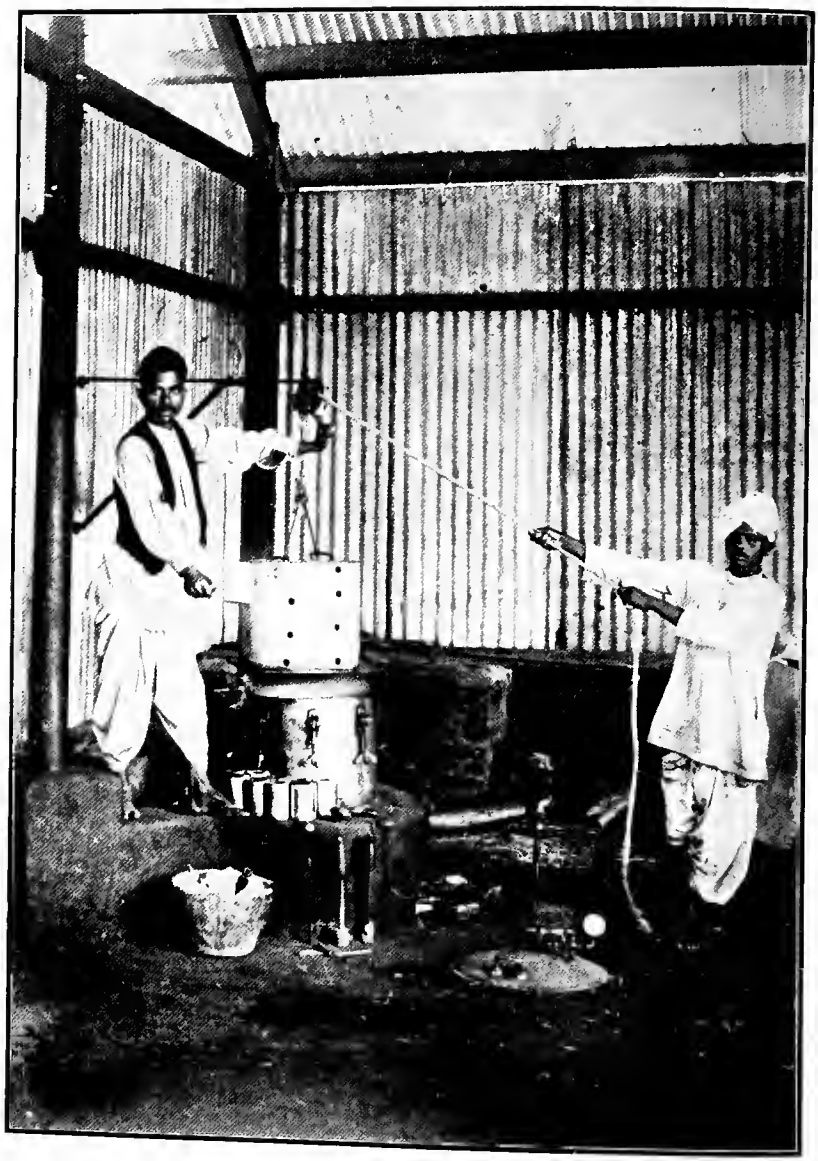
1. It can develop a pressure of 30 lbs. per square inch. As a rule only ten pounds pressure is used in canning. Steam pressure is a much more effective steriliser than simply boiling water.

No. 19.



Canning outfit with Cans and soldering apparatus.

No. 20.



Showing the method of putting in or taking out the cans, when the apparatus is hot.

2. A fire can be built under this model. Such a type suits Indian conditions better than one with a fire-box.

The process employed was as follows :—

The mangoes were skinned, stones removed, pulp sliced and filled into the tins. In some cases the juice was only put into the tins. The lid was soldered on each tin, leaving a small central hole (the vent hole) open. The tins were put into the apparatus and kept at varying pressures for different periods. This process is called *Exhaustion.*

The tins were then removed and the vent holes sealed. The tins were put back in the apparatus and subjected to a further period of treatment, at varying pressures. This is called *Sterilisation.*

The results of the 1913 canning were somewhat vitiated by either faulty cans or faulty solder and about 40 per cent. went bad. The others varied considerably in flavour and consistency. The best results were got with the tins filled with juice of country mangoes, exhausted for 3 minutes at 2 lbs. pressure and sterilised for 15 minutes at 10 lbs. In some cans the consistency was watery and the taste sweet, in others bitter.

The results of the 1914 canning gave the following conclusions :—

(1) The Alphonse juice remained perfectly good by exhausting it for 5 minutes at 0 lbs. and sterilising for 15 minutes at 3 lbs. pressure.

(2) In all cases where the cans have been filled with pulp there has been great shrinkage combined with slight deliquescence of the pulp. The exact amount of pressure required for this process cannot at present be given.

(3) The country juice exhausted for 5 minutes at 0 lbs. and sterilised for 10 minutes at 5 lbs. has remained in an excellent condition.

(4) In the case of Pairi and Shahabuddin, there has been a defect of some sort or other in all the processes and nothing definite can at present be said with regard to these.

(5) Exhaustion seems to be an essential part of the operation as the cans done without it are slightly more bitter than those that were exhausted and processed. It is rather difficult to say why this operation should be necessary, but exhaustion beyond 100° C. and above 5 minutes seems to spoil the contents.

The following are analyses, kindly made by the Agricultural Chemist, Bombay, Poona, of fresh Alphonse fruit and canned Alphonse juice :—

	Juice from fresh Alphonse fruits.	Canned juice from Alphonse fruit.
	Per cent.	Per cent.
Moisture ..	80·50	80·49
Acidity as Tartaric acid ..	1·264	0·567
Percentage of sugar on dry matters.		
Crystallizable sugars ..	47·01	43·43
Non-crystallizable sugars ..	3·66	17·95
Total sugars ..	50·67	61·38

The kernel of the fruit contains a large amount of starch and is sometimes used as food by the poor in parts of the Central India.

In a letter received from the Overseer, Public Gardens, Pachmarhi, on 17th June 1913, the following information is contained :—

" Among the hilly tracts of Hoshangabad District, there are several aboriginal tribes, namely Gonds, Katia, Kotwar, Nawghana, and Korkoos, who collect mango stones and preserve the same as a food-stuff. The stones are first of all dried in the sun for a week or so and then roasted. The process of roasting is as follows :—

" The stones are first spread on a thin layer of grass and are covered with a layer of the same thickness. Fire is applied to the grass-covered stones. When flames are out a small stick is taken and they are turned up and down to secure partial roasting. They are then exposed to the sun for a couple of days before they are stored up. When desired a sufficient quantity is taken out for consumption. First they remove the shells to expose the kernel which is crushed into coarse powder. It is then packed in a thin piece of cloth and at night the bundle is taken to a pool of water and allowed to remain there for the night with a heavy stone placed above it. Early in the morning, the bundle is taken out and brought home. It appears that in this way, the astringent taste of the powder is removed. After completely washing, the powder becomes milky white. It is then put

into boiling water and cooked for some time. It is generally eaten with milk, curds, butter-milk or pulse."

There are also other uses of the mango. When green, the stone is extracted, the fruit cut into halves or slices and—

(1) put into curries.

(2) made into pickles with salt, sweet oil, chillies and other ingredients.

(3) made into preserves known as "Moramba" by being boiled and cooked in syrup.

(4) dried and made into the native "Amboshi" used for adding acidity to certain curries.

(5) when very young cut into small pieces, mixed with salt and chillies, forming an excellent "Chatni," so great a favourite among Indians.

When ripe—

(1) it is made into curry which has a sweet acid taste.

(2) the juice squeezed, spread on plates and dried, forms an excellent thin cake known as "Amb-poli."

The jungly varieties, on account of their dense shade and evergreen character, make excellent roadside trees and groves for camping grounds. It is folly to grow a good variety for shade as the fruits are always eaten and the tree is as a rule less vigorous and spreading than the jungly type.

CHAPTER XI.

Mango Classification.

The Classification of Mango Varieties.—(Printed first as an article in the Agricultural Journal of India, Vol. X, part IV, October 1915.)

In India the number of mango varieties is immense.[1] Watt states that Maries collected some 500 varieties in India, but very few attempts have been made to describe these. Maries made a start by describing the varieties of his own district and the same has been done by one or two others, notably Woodrow and Hartless. One or two varieties have been carefully studied, but as a whole they have not been examined with a view to classification. Such a process is necessary if we are to have any definite knowledge as to the types of this fruit and their distribution and possibilities. This *embarras de richesses* in forms of mango fruits has apparently existed in India for centuries.

(1) Dictionary of Economic Products of India, Vol. V, p. 149.

In 1638, we find Van Rheede[1] writing " Caeterum fructuum horum mangas, haud secus ac pomorum ac pyrorum nostratium variae dantur species, quae pro regionum, diversitate plurimum variant." (Translation—Of these other fruits, mangoes, not unlike our apples and pears, are found in several types, which vary greatly according to the nature of the region.)

Without some classification we have chaos. According to what scheme can this chaos be reduced to order ?

In all classification the main point is to extract from a multitude of characters those which are common and constant in individuals or types. It seems to us that since mango trees are at present named and recognised by their fruit we should take the fruit as the part by which to classify. The least variable external character of the fruit in a given variety is the shape of the fruit. The size and weight vary considerably among fruits of the same tree. This is well shown in photo No. 21.

In contrast with the first figure stands photo No. 22, which contains mangoes of different varieties, namely :—

1. Mothi Pairi.
2. Pairi.
3. Khoont.
4. Popatya.
5. Cowasji-Patel.
6. Batli.
7. Borsha.
8. Alphonse.
9. Mulgoba.

The diversity in shape is at once apparent.

A classification based on fruit characters is undoubtedly artificial, but as a means for reducing to some kind of order the existing chaos of forms, an artificial is as good as natural classification. Natural classification will come later when the existing forms have been catalogued and described.

In classifying mango fruits we may with reason follow the plan adopted in 1875 for the classification of grape varieties by the International Ampelographic Commission at Kolmar. The three main classes then suggested were—

(1) *Round fruited.*—Those varieties with fruits in which the length from stalk to apex is equal to or less than the breadth.

(2) *Long fruited.*—Those varieties in which the length is distinctly greater than the breadth.

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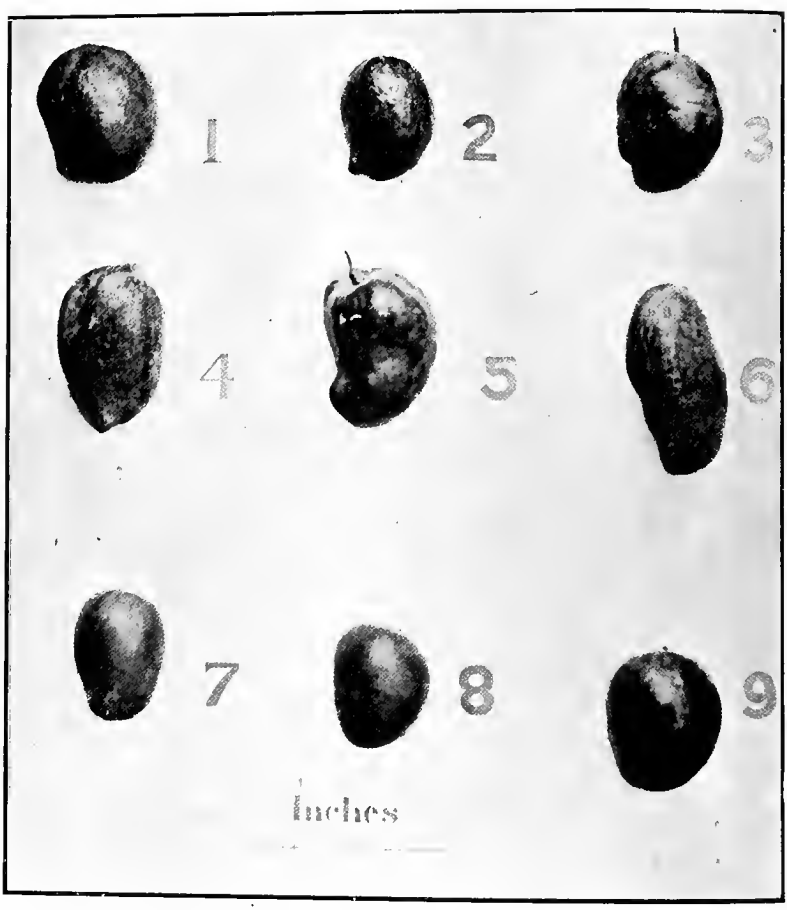
(1) Hortus Malabaricus.

No. 21.

Pairi fruits from one tree, showing constancy in shape and variation in size.

No. 22.



Mango fruits of different varieties, showing variation in shape.

(3) *Indefinite.*—Those that fall in neither class on account of being on the border line between the classes and, in addition, of somewhat variable nature.

To make the above strictly logical, class (1) should contain only those that have fruits with the axis from stalk to tip constantly shorter than the transverse axis and class (3) should contain the forms with both axes equal and also any doubtful or variable forms. A somewhat similar classification was suggested by Woodhouse[1] for the mangoes of Bhagalpore.

This mention of axes means that we have to consider in what position a mango fruit should be for description. It is a useful convention to describe a mango fruit lying on its side with the beak to the left. One can then talk of its length (axis between stalk and apex), breadth (axis at right angles to length and parallel to plane in which the mango fruit is lying) and thickness (axis at right angles to breadth and vertical to surface on which the fruit is lying).

In the above-mentioned article by Woodhouse and in a more recent article by Popenoe[2] the various parts of the fruit have been named and the methods of description suggested. We may content ourselves with describing the parts, namely right and left shoulders, basal cavity (attachment of stalk), beak, apex, and sinus (on left side). In addition, size in three dimensions, weight, colour, surface and the nature, closeness and distribution of the small dots on the skin should be described. After the fruit is cut the flesh should be described as to taste, colour and stringiness, the skin as to thickness, and the stone as to size, weight, fibre, and markings. The following is an example of a mango fruit partly thus described :—

Dudh-Shendrya.—Weight 245 grammes ; measurements $9 \times 6 \times 5$ cm., luscious, colour of the flesh pale yellow, no fibres ; colour of the outer skin yellow to brick red, glands small white, slightly rough ; basal cavity slight, left shoulder slightly higher than right, beak slight, 2 cm. from apex, rounded ; weight of stone 37 grammes and its measurements $7{\cdot}2 \times 4 \times 3{\cdot}2$ cms.

Such descriptions will enable us to put mangoes into classes subordinate to the main three classes just mentioned. These subordinate classes would be distinguished by the characteristic shape of the fruit, e.*g.*, the Alphonse class with high left shoulder and small or missing

(1) Quarterly Journal of the Department of Agriculture, Bengal, Volume II, p. 168, January 1909.

(2) Proceedings of the American Pomological Society, 1913.

beak. Under this would come all the varieties of the Alphonse shape, but differing in colour and taste, *e.g.*, Alphonse, Fernandin, etc. In tabular form the scheme would work out as follows :—

Name of the variety.	Taste.	Pulp.	General description.
Alphonse Class.			Shape Fig. 38.
Alphonse ..	Very luscious, fragrant.	Reddish in the middle and pale yellow on the outside.	Left shoulder higher than the right ; thin skin closely attached to flesh ; dots minute.
Fernandin ..	Very luscious.	Bright yellow ..	Bright red on exposed side and yellowish-green on non-exposed side. Thick skin closely attached to flesh. Surface rough and warty, with small yellow dots.
Madan Ban ..	Luscious ..	Yellow to red, thick consistency, no fibres.	Yellowish-green ; beak slightly present ; both shoulders falling equally ; small black dots present.
Popatia class.			Shape, Fig. 32.
Popatia ..	Slightly acid, pleasant.	Yellow ; rather tough ; fibre small.	Fruit bulged in the middle and narrowed at the stalk end ; green to red dots prominent and close.
Masana ..	Bitter ..	Pale yellow, tough .	Skin green and orange, small dots present ; beak sharp and prominent.

If we desired to make a world-wide classification, we should make territorial classes embodying the Indian, West Indian, Cuban, Philippine mangoes, and these could again be grouped under the two great heads of monoembryonic and polyembryonic. So far only monoembryonic mangoes are known in India.

A word or two regarding the origin of mango names may not be out of place.

It seems that the Indian is somewhat eccentric when he comes to naming mango fruits and tacks a fanciful title on to every seedling that produces good fruits. A large number of these may frequently be traced to colour of the skin, shape, size, etc. The following instances will clearly show how some of the mango varieties have been named :—

How named.	Examples.
From outward colour ..	*Dalimbya* (like the colour of pomegranate). *Kalya* (dark coloured fruit).
From shape ..	*Batli* (like a bottle). *Kelya* (like a plantain). *Popatia* (beak like a parrot). *Ladoo* (ball like).
From certain outside marks,	*Nakya* (one having a prominent nose or beak). *Bhokya* (one with a hole).

How named.	Examples.
From size ..	*Naralya* (big as a coconut). *Mahalungya* (like a Citron).
After some persons ..	*Alphonse* (after Alphonse Albuqerque). Cowasji-Patel (a proper name). *Karel* (Carriera). *Collace* (doubtful).
After some titles or great personages.	*Maharaja* (King). *Maharani* (Queen). *Badashah* (Emperor). *Baji Rao* (one of the Maratha Peshwas). *Birbal* (The Prime Minister of Akbar). *Chhatrapati* (King).
After some romantic ideas.	*Madanban* (arrow of Cupid). *Dilhouse, Dilpasant, Dilbahar, Dilkhush* (delight of the heart).
From consistency ..	*Dahi-amba* (curd-like). *Pithya* (flour-like). *Khobarya* (like the kernel of a cocoanut).
After the smell of the juice.	*Shepya* (like *Peucedanum graveolens*).
After surroundings ..	*Saundadya* (Saundad = *Prosopis spicigera*, that stood quite close to a mango tree). *Warulya* (owing to its nearness to a big white-ant hill); *Warul* meaning an ant-hill.
From the general arrangement of the fruits on the inflorescence stalk.	*Toranya, Ghad-amba* (cluster like).

In some cases where the fruits resemble each other in shape, but differ in other characters some words either denoting size or place are prefixed, thus *Mothi Pairi* denotes that it resembles Pairi in shape but is big in size. Similarly, *Pachkhodi-Dodi* and *Hiswalchi-Dodi* resemble Dodi mango in shape but are named after their respective places, as they differ in other characters.

We thus find that the names give us no help in the methods of classification as it is likely that the same name has been given to more than one variety or the same variety may occur under different names in different localities.

The results of an arbitrary classification based on fruit characters may lead us some little way towards determining the ancestral type or types from which our present mango varieties have sprung. This will be of great scientific interest, and may also be of practical value in assisting us to produce new forms.

The following is the list of some of the varieties classified from fruit characters only and their description.

Mango Classes.

Cohort I :—

Round fruited—

Order No. 1 " Roos "

Varieties :—

(See description in Appendix.)

Roos.

Dilpasant.

Bishop.

Rawanya.
Gendya.
Dildar.
Kare-manv.
Gadhemar.
Dilhouse.

Order No. 2, " Ramphalya. " Very broad in proportion to length.

Varieties :—

Ramphalya.
Cheep.
Mogarya.
Sakhargooty.
Fulambry.
Shakarkand.
(Thorla).
(Dhakta).
Gulkand.
Dilkhush.

Order No. 3, " Dalimbya. " Shoulders ridged.

Varieties :—

Dalimbya (Nandgaon).
" (Khedshivapur).

Cohort II :—

Long fruited :

Order No. 1, " Batli. " Much elongated.

Varieties :—

Batli.
Dodi.
Calcuttio.
Kharki.
Sharavandodi.
Collace.
Kelya.
Kalmi

Order No. 2, " Totapuri. " Elongated with downward pointing beak.

Popatya.
Modya.
Totapuri.
Saundadya.

Order No. 3, " Cowasji-Patel. " Elongated, slight beak and ridged shoulders.

Cowasji-Patel.
Karel.
Godhadya.

Order No. 4, " Alphonse." No beak ; high left shoulder.

Alphonse.	Mankurad.
Fernandin.	Rebel.
Musherad (Tambada).	Katarya.
,, (Safet).	Madan-Ban.
Ilar.	Jamb.
Goa Alphonse.	

Order No. 5, " Pairi. " Broad marked beak.

Pairi. Khobarya (Menavli),

Unclassified.

Kaju.	Cluster.
Walkya.	Kharbujya.
Belya.	Nagya.
Kurhadya.	Angirya.
Balimanv.	Maldej (Pokal)
Shepya.	

The selection of varieties for different localities.—In selecting a variety of mango for a particular tract, several features have to be considered. The purpose for which it is to be grown, *viz.*, for home consumption or market or for preserves should be given due weight. In places situated close to railway stations or to big markets the most leading varieties of mangoes such as Pairi, Alphonse, Mulgoba, Batli, etc., are grown. It is always desirable, however, to grow varieties of lasting qualities in places far remote from railway communication or other transport facilities, as varieties like Pairi soon decay after ripening and are hence not well suited for such purposes.

The question now arises as to what varieties are best suited for particular tracts. Information on this point is however not complete but the following tabular statement may be useful :—

Deccan.	Southern Gujarat.	Southern Maratha Country.	Konkan.
Pairi ..	Pairi ..	Pairi or Raspuri ..	Pairi, Alphonse and Pavsha for Ratnagiri and Alibag districts.
Alphonse ..	Alphonse ..	Alphonse or Badami .	
Borsha ..	Calcuttio ..	Mulgoba.	
Cowasji-Patel .	Batli ..	Sundershaha ..	Cowasji-Patel in addition to above in Thana district.
Shendrya ..	Roos ..	Bali-Manv.	
Khoont ..	Gopto ..	Kare-Manv.	
Mulgoba ..	Cowasji-Patel ..	....	Kala-Ishad and Fernandin in Karwar district.
Batli.			

For those tracts which are very dry and whose annual precipitation does not go beyond 15 inches, it is desirable to raise stock plants and graft the above recommended varieties *in situ* as it has been found by experience that grafted plants direct from pots do not thrive in such places.

On account of the extended range of the districts and of the varying soil and climatic conditions that prevail within them, the above recommendations must be accepted with caution.

A variety may behave in a certain manner, ripen its fruit during a particular period and show other habitual characteristics when growing in certain conditions of soil, climate, and cultural methods; but when it is grown in different conditions, it may behave in a very different manner. In other words, the variety is subject to the influence of the conditions in which it is grown, either in regard to flowers or fruits. For example, in the Konkan the mangoes flower earlier than in dry tracts by about a month.

Productiveness.—At the present stage it is not possible to give the relative yield of most of the varieties although it is a character of prime importance.

Time of Maturity.—The time of maturity is an important varietal quality in the mango. The Fernandin comes always late into the market. A variety of Shravan-Dodi in Satara District is generally mature after the middle of July. In Bombay market the Madras varieties, *viz.*, Totapuri and Neelumb, generally come into the market from July onwards.

The following are some of the leading varieties that keep well:—

Alphonse.	Borsha.
Fernandin.	Batli.
Sakharia.	Khoont.

APPENDIX.

Lead Arsenate.

1 oz. lead arsenate.

1 oz. lime.

2 gallons water.

Rosin compound.

Powder 2 lbs. of rosin and 1 lb. of washing soda (sodium carbonate) crystals. Place these in a kerosene tin or large metal vessel, with enough water to cover them and boil.

Continue boiling till both are dissolved and then slowly add cold water to the steadily boiling fluid. Water is to be added, very little at a time, for fear of chilling the liquid, and the mass should gradually be brought up to 2 gallons. The liquid changes as the boiling proceeds, becoming thick and soapy; after boiling for half an hour or longer, the liquid becomes clear, thin, of a deep brown colour. Continue boiling, pouring a few drops of the mixture into cold water at intervals. At first the wash on mixing with cold water forms a slightly milky opaque fluid, and after some minutes' further boiling, it forms a clear amber liquid on being mixed with cold water.

This is the test of the liquid being finished and it should on cooling remain clear. To this stock solution 6 gallons of water may be added to make the strong wash, 10 gallons to make the normal wash. The wash keeps indefinitely if properly prepared, and it is best to keep the stock solution and dilute it as required.

Crude Oil Emulsion.

1 gallon emulsion.

66 gallons water.

Inkosopol

(made by the Indian Cotton Oil Co., Navsari).

1 lb. Inkosopol.

8 gallons water.

Bordeaux Mixture.

Take—

Copper sulphate, 12 lbs.
Slaked lime, 18 lbs.
Water, 100 gallons.

Dissolve the copper sulphate in 3 gallons of hot water in a wooden tub. Mix the lime in a bucketful of water into a thin paste. Pour the copper sulphate solution and lime paste simultaneously in a wooden cask containing 30 to 40 gallons of water and stir well. (If a bright steel blade dipped in this mixture turns red by the deposition of free copper the mixture is likely to burn the leaves and more lime should be added till no copper is deposited on the blade.)

Add water to make up to 100 gallons. Ten lbs. of soft soap may be added. It may not be necessary when there is no danger of the mixture being washed away by rain.

Fish Oil Resin Soap.

One gallon fish oil resin soap.

Sixty gallons water.

Descriptive List of Names of Varieties.

Name.	Length in c.m.	Breadth in c.m.	Thickness in c.m.	Taste.	Flesh.	Weight in grammes.	Stone.	General appearance.	Shape.
			Cohort I—Round fruited.		*Order No.* 1. *Roos.*				Figs.
Roos (Navsari) ..	12	11	9·5	Very luscious ..	Orange-red, fibre considerable.	807	10×8×4·5	Green to orange, fruit broad, beak very scarcely perceptible, with a slight depression below it, a big fruit and a cooking sort.	1
Dilpasant (Nandgaon).	8·5	8	5·2	Slightly turpentiny but delicious.	Canary yellow, no fibres, thick pulp.	471	44 gms. 7×4·5×3·2	Yellow to apple-red, glands black and wide, smooth, left shoulder slightly higher than right, beak absent.	2
Bishop (Goa) ..	15·2	10·9	8·5	Sweet when just ripe but becomes useless after full ripening, resembles the taste of Cowasji Patel.	Pale yellow at the sides and reddish in the middle, slightly fibrous.	892	10·7×6×4	Greenish-yellow, beak absent or very scarcely perceptible, a big sized fruit.	3
Rawanya (Menavali)..	9·2	8·4	7·4	Delicious, slightly piquant.	Orange ; soft and buttery.	355	30·5 gms. 7·8×4·5×2·2	Green shading with canary yellow, glands prominent, left shoulder higher, no beak.	7
Gendya (Menavali) ..	6·5	6	5·5	Pungent and sweet.	Pale yellow, pulpy.	161	14·5 gms. 4·6×3·3×1·7	Greenish yellow, glands not prominent, high left, no beak.	8
Dildar ..	5·5	6·9	5·4	Heavy and sweet.	Deep orange, slightly fibrous.	160	23·5 gms. 4·9×4·2×2	Green with slight yellow flush, glands moderately prominent, left shoulder high, beak slight.	4

Kare-manv (Dharwar).	9·9	7·9	6·5	Excellent, very slightly turpentiny and pungent.		320	17·5 gms. 7·5×3·8×2·2	Deep orange, glands prominent, shoulders equal, beak prominent and pointing down.	5
Gaddhemar (Navsari) .	12·5	10·5	9·5	Luscious, slightly heavy.	Pale yellow ..	614	11·5×6×4·5	Greenish brown, glands present, beak slightly present and a small depression just below it.	6
				Order No. 2.	"*Ramphalya.*"				
Ramphalya (Menavali).	6·5	5·2	4·5	Sweet and pleasant.	Whitish yellow, slightly fibrous.	201	26·5 gms. 6·5×4·2×2·5	Green with orange flush, glands fairly prominent, left shoulder very high.	10
Sakhar-gooty (Menavali).	5·5	5	5	A most delicious fruit.	Pale yellow, no fibres.	94	20·5 gms. 4×2·8×1·8	Canary yellow, slightly tinged with green, glands not very prominent, left shoulder very high.	11
Fulambry (Menavali).	6	6·7	5·6	Slightly turpentiny.	Pale yellow, pulpy, slightly fibrous.	165	23·5 gms. 5·2×3·5×2·2	Yellow, glands not prominent.	12
Shakarkand (Thorla) (Menavali).	7·0	7·8	6	Pleasant ..	Orange, slightly fibrous.	226	31 gms. 6·5×4·5×2·5	Greenish yellow, very high left, slight beak.	17
Shakarkand (Dhakla) (Menavali).	7	6·5	6		Orange, slightly fibrous.	205	34 gms. 5·2×3·5×2	Green, glands prominent, very high left.	20
Gulkand (Menavali) ..	7	6·5	6	Sweet, slightly heavy.	Orange, pulpy, no fibres.	164	21 gms. 4×2·5×1·7	Green with orange flush, glands prominent, left shoulder high.	18

Name.	Length in c.m.	Breadth in c.m.	Thickness in c,m.	Taste.	Flesh.	Weight in grammes.	Stone.	General appearance.	Shape.
Cheep (Menavali) ..	7·0	6·5	5·5	Turpentiny, slightly sweet.	Pale reddish yellow.	167	25 gms. 6·7×3·6×2	Green with reddish yellow flush, glands prominent on green part, very high left, beak scarcely perceptible.	Figs. 13
Mogarya (Menavali) ..	7·8	6·0	5·5	Sweet and pungent.	Pale orange, slightly fibrous.	177	27 gms. 5·3×3×1·8	Green with pale green flush, glands inconspicuous, left shoulder high.	14
Dalimbya (Nandgaon).	9	7	5·5	Luscious ..	Canary yellow, thick consistency, no fibres.	354	32 cms. 6·5×4×3·2	Deep yellow to light orange, glands white or black wide apart, smooth, left shoulder much higher than right, beak slight, 3 c.m. from apex, basal cavity deep, apex obtuse.	15
Dalimbya (Khed-Shivapur).	8·5	7	4·5	Luscious ..	Yellow to red, thick consistency, no fibres.	300	29 gms. 6×4×3	Pomegranate red to orange, glands large yellow, close and smooth, left shoulder slightly higher than right, beak slight 2 c.m. from rounded apex, basal cavity distinct.	16
Dilkhush (Menavali)..	6·0	4·5	4·5	Slightly turpentiny, otherwise pleasant.	Orange, fibrous ..	182	25 gms. 5×4×2·5	Orange with brickred fluah, glands prominent, left shoulder high, beak prominent.	19

Dodi (Nandgaon) ..	11·5	6	4·5	Luscious ..	Yellow to red fibrous.	369	52 gms. 10×4·5×3	Green to yellow, glands yellow, distant and large but not rough, shoulders falling equally, beak not visible, basal cavity slight, apex rounded.	21
Batlee (Navsari) ..	15	7	7	Slightly bitter but luscious too.	Deep orange ..	414	13×4×3·5	Orange green, glands present, fruit longer than broad, beak scarcely perceptible.	24
Calcuttio (Navsari) ..	15·5	8·5	8	Luscious, heavy..	Orange, slightly fibrous.	534	14×4×4	Greenish brown, glands present but not closé, left shoulder slightly higher than the right, beak very scarcely perceptible, fruit longer than broad.	22
Shravan-Dodi (Menavali).	13·5	6	5·8	Pleasant, slightly heavy.	Orange, slightly fibrous.	328	32 gms. 12·5×3·5×1·9	Green with orange flush, glands far apart and prominent, left shoulder high, beak slight.	25
Collace (Goa) ..	10·2	6	4·5	Sweet ..	Red coloured, shaded yellow, slightly fibrous.	223	9·3×4×3·2	Yellowish green, both shoulders equally falling, beak very slightly perceptible, moderately thick skin.	26
Kelya (Menavali) ..	8	5	4·5	Sweet and pleasant.	Orange, slightly fibrous.	240	39 gms. 8·5×3·8×3·0	Green with crimson flush, glands fairly prominent, left shoulder high.	23
Kharki ..	7·3	5·0	4·0	Slightly turpentiny.	Orange yellow, fibrous.	74	14·5 gms. 4·8×2·3×1·5	Green with orange flush on shoulders, glands small and not prominent, left shoulder high.	27

Name.	Length in c.m.	Breadth in c.m.	Thickness in c.m.	Taste.	Flesh.	Weight in grammes.	Stone.	General appearance.	Shape. Figs.
Chatrapati (Nandgaon)	10·5	6	5	Pleasant with sweet taste.	Pale yellow, consistency thick.	288	9×3·8×2·8	Green, glands few and quite apart, beak present, thin skin.	30
Bhungya (Menavali) ..	9·3	6·4	5·5	Pleasant, rather heavy.	Pale orange, pulpy.	204	24 gms. 76×3·7×2·2	Orange yellow, glands moderately prominent.	28
Ghadyali (Menavali) ..	9	6	5·2	Faint and pleasant.	Orange yellow, pulpy.	182	33 gms. 9×3·3×2	Greenish yellow with crimson flush, glands prominent, both shoulders equal, beak prominent.	31
Kalmi (Menavali) ..	14·5	9·4	9·7	Not attractive, faintly turpentiny.	Yellowish white, slightly rough and fibrous.	810	34 gms. 12×5·5×2·2	Greenish-reddish yellow, glands far apart and prominent, very high left, slight beak.	29
				Order 2.	*Totapuri Class.*				
Popatia (Navsari) ..	16	7	6	Slightly acid, pleasant.	Yellow, rather tough, fibre small.	341	14·5×3·5×3	Green to red, glands proniment and close, beak present, fruit bulged in the middle but narrowed at the stalked end.	32
Modya (Menavali) ..	9·2	6·3	5·6	Slightly turpentiny.	Yellow, slightly fibrous.	222	34·5 gms. 7·5×3·7×2·2	Green with yellow flush, glands slightly prominent, beak prominent.	33

Soundadya (Nandgaon)	12·5	8	6·5	Sweet and pleasant.	Yellow, fibrous ..	482	55 gms. 11×5·2×3·5	Yellow to orange, glands white, close, smooth, shoulders equal and level, beak coarse and well-marked, 3 c.m. from apex, apex rounded, basal cavity deep, an extraordinarily flat mango.	34
				Order 3. Cowasji Patel Class.					
Cowasji Patel (Ganeshkhind Botanical Gardens, Kirkee).	15	8·5	6	Rather insipid, full of pulp, no fibres.	Pale yellow ..	614		Pale green, glands black or white, close and fairly rough, both shoulders falling, right larger than left, beak marked and pointing downward, 3 cm. from obtuse apex, sinus side flat and broad, outline very rough and knobby, a fruit of good preservative, when raw.	36
Karel (Goa) ..	9·5	8	6	Turpentine flavour, slightly sour.	Orange red near the stone shading to pale yellow at the sides.	287	8·7×6·5×4·5	Yellow, left shoulder higher than the right, beak slightly present, a small groove just below the beak, useful in pickles when raw.	35
Godhadya (Nandgaon).	12	75	6	Turpentiny and sour.	Orange red, fibrous.	551	69 gms. 10×4·5×3·8	Green to yellow, glands small yellow, close-set and rough, shoulders level, beak slight, 3 c.m. from obtuse apex, basal cavity distinct, fruit very irregular, in shape like Cowasji Patel.	37

Name.	Length in c.m.	Breadth in c.m.	Thickness in c.m.	Taste.	Flesh.	Weight in grammes.	Stone.	General appearance.	Shape.
				Order 4. "*Alphonse Class*"					Figs.
Alphonse (Ganeshkhind Botanical Garden, Kirkee).	9	6	4·5	Very luscious, fragrant smell.	Reddish in the middle and pale yellow on the outside.	350		Left shoulder higher than the right, thin skin closely attached to flesh, glands minute. A fruit of a lasting quality.	38
Fernandin (Goa) ..	10·2	6·5	5·2	Highly delicious..	Bright yellow, thick consistency.	334	8×4×3·9	Bright red on exposed side and yellowish green on non-exposed side, small yellow glands present, surface rough and wasty, fruit longer than broad, slight prominence below left shoulder, thick skin closely attached to flesh. A fruit of superior sort.	39
Musherad (Tambada), (Goa).	9·8	8·2	7·5	Fine, rich flavour but not so luscious as Fernandin.	Reddish, rather juicy, slightly fibrous.	298	Not available.	Bright red on the shoulders, shading to yellowish green below, beak scarcely perceptible, thin skin, an attractively coloured fruit.	40
Musherad (Safet) (Goa).	9·5	6·5	5·2	Slightly sweet ..	Creamy white ..	284	8·2×4×3·2	Greenish-yellow with crimson red at the stigmatic end, left shoulder slightly higher than the right, thin skin.	40

Ilar (Goa) ..	6·5	4·5	3·2	Acid taste, sweet and delicious but slightly turpentiny.	Reddish yellow, pulpy, no fibres.	97	5·2×3×2	Greenish yellow, beak scarcely perceptible. A very small sized fruit.	41
Goa Alphonse (Goa)..	10·9	8·5	6·5	Very sweet and piquant.	Yellowish, no fibres.	385	7·4×4·6×3·2	Greenish yellow with small glands on the surface, left shoulder higher than the right, beak very slightly perceptible.	42
Mankurad (Goa) ..	8·6	6·5	5·2	Very luscious ..	Yellowish, no fibres.	226	7·2×4·5×3	Left shoulder very slightly high, beak absent, thin skin firmly attached to the flesh.	43
Rebel (Goa) ..	10·2	6	4·5	Slightly bitter and turpentiny.	Red, shaded yellow, juicy.	211	7·4×4×3·2	Greenish yellow, beak absent, moderately thick skin.	47
Katarya (Nandgaon)..	10	6	4	Delicious but turpentiny.	Yellow to red, no fibres.	290	51 gms. 8·2×4·5×3	Green to yellow, glands large, black or white, wide apart, slightly rough, left shoulder a little higher than right, beak scarcely perceptible, 3 c.m. from rounded apex, basal cavity slight.	44
Madan-Ban (Nandgaon).	13	7	6	Delicious ..	Yellow to red, thick consistency, no fibres.	584	37 gms. 8·8×3·8×2·5	Yellowish green, small black glands present, left shoulder slight high, beak very slight, thin skin.	45
Jamb (Menavali) ..	8·5	6	5·5	Sweet, not pungent, no turpentine.	Deep yellow, not fibrous, pulpy.	145	21·5 gms. 5·5×2·6×1·5	Green with deep red on shoulders, glands prominent, left shoulder higher.	48

Name.	Length in c.m.	Breadth in c.m.	Thickness in c.m.	Taste.	Flesh.	Weight in grammes.	Stone.	General appearance.	Shape.
				"Pairi Class."					Figs.
Pairi (Ganeshkhind Botanical Garden, Kirkee).	10·5	8·5	7	Delicious with an acid taste, slightly juicy.	Brownish orange colour, no fibres.	360	..	Both shoulders fall about equally, beak most prominent, thick skin, bright red colour on the exposed shoulders and green to yellow on other sides.	49
Khobarya (Menavali) .	5·9	4·9	4·9	Pungent and pleasant.	Yellow fibrous ..	185	26·5 gms. 5×3×1·8	Green with yellow flush, glands prominent, left shoulder high, beak prominent.	50
Sundry (Menavali) ..	5·3	4·6	4	Turpentiny, sweet.	Pale yellow ..	70	11·5 gms. 4·5×2·7×1·7	Yellow to green, left shoulder high, beak slight.	51
Surki (Menavali) ..	7	6	5·4	Pleasant ..	Pale reddish yellow, pulpy.	166	17 gms. 5·7×3·6×1·6	Deep green with crimson flush, glands not prominent.	56
Matetin (Goa) ..	8·2	7·3	6	Fine, rich and delicious.	Reddish, no fibres.	210	6·5×4·5×3·2	Reddish at the shoulders and yellow at other portions, beak prominent, thin skin.	59
Masana (Navsari) ..	14·5	9·5	8	Bitter ..	Pale yellow, reddened in the middle, tough.	532	13×5·5×3·5	Green and orange, small glands present, beak sharp and prominent.	52
Makhanio (Navsari) ..	13	10	6	Sweet ..	Yellow with reddish tinge.	267	9×4·5×3	Yellow to red, very small glands present, beak prominent, thin skin.	53

Kelya (Bopardi) ..	9·6	7 0	6·5	Delicious and piquant.	Light yellow, pulpy.	326	29·5 gms. 7·5×3·3×2·0	Yellow with red flesh, glands not prominent, left shoulder high, beak distinct.	54
Birbal (Nandgaon) ..	11	6·8	5·5	Delicious ..	Canary yellow, slightly fibrous.	403	45 gms. 9×4×3·5	Yellow to deep orange when ripe, glands wide apart, black with white ring, not prominent, shoulders equal and falling, beak well marked, surface smooth, basal cavity slight.	58
Badashaha (Nandgaon)	8·5	6·2	5	Luscious ..	Pale red, slightly fibrous.	377	44 gms. 7·5×4·5×3·5	Orange red on the shoulders and green on other sides, glands small, black and not prominent, both shoulders falling equally, beak well-marked, coarse and blunt.	55
Kalya (Nandgaon) ..	9·5	6·5	5	Sour ..	Pale yellow, fibrous.	376	56 gms. 8·5×4×3·8	Green to bronze, glands small, black or white, close, smooth, left shoulder higher than right, beak slight 3 c.m. from obtuse apex, basal cavity fairly deep.	60
Dattapuri (Nandgaon).	10·5	7	6·2	Delicious ..	Pale yellow, thick consistency.	488	53 gms. 9×4×3·5	Green to light orange, glands large, black with white ring, wide apart and smooth, left shoulder slightly higher than right, beak well-marked and 2·5 c.m. from apex, basal cavity slight, apex obtuse.	61

Name.	Length in c.m.	Breadth in c m.	Thickness in c.m.	Taste.	Flesh.	Weight in grammes.	Stone.	Genral appearance.	Shape.
									Figs.
Maharani (Nandgaon).	10·2	7	5·5	Acid taste, turpentiny but pleasant.	Pale yellow, thick, no fibres.	322	30 gms. 8×3·5×2·8	Yellow to orange, glands white or black, close and smooth, left shoulder slightly higher than right, beak slight and 2 c.m. from rounded apex, basal cavity absent.	62
Gadgi (Poona) ..	11	8·7	9·0	Sickly sweet ..	Orange, pulpy ..	599	55·5 gms. 8·5×5·4×2·4	Deep green, glands large and prominent, left shoulder slightly high, beak almost imperceptible.	69
Pandharpurya (Menavali).	7·5	6·7	6·0	Delicious and piquant.	Yellow, pulpy ..	229	25 gms. 6×3·5×2·3	Greenish yellow with crimson flush, glands moderately prominent.	63
Bhurya (Menavali) ..	7·2	7·6	6·3	Slightly turpentiny but sweet.	Pale orange, fibrous.	263	21 gms. 6·2×3·2×2·0	Glands few and moderately prominent, shoulders falling equally, beak scarcely perceptible.	64
Dilhouse (Menavali) ..	9·5	9·5	8·0	Sweet and slightly pungent ; no turpentine.	Canary yellow, slightly fibrous.	395	41·5 gms. 6×3·8×1·6	Canary yellow with rosy flush, glands not prominent, beak scarcely perceptible, skin fine and scent fragrant.	9
Shaverirmaon (Goa)..	10·2	8·3	5·2	Moderately sweet.	Yellow shading to red in the middle, juicy, fibrous.	330	9·4×6·5×6	Yellow, small *peru* leaf-like lines on the surface, left shoulder high.	

Sanna-yeli-Mav (Menavali).	8·0	6·5	5·5	Not pleasant ..	Pale yellow, fibrous.	404	48 gms. 8·5×4·5×2·2	Green with dirty yellow flush, left shoulder high, beak not prominent.	65
Kelya No. 2 (Menavali).	8·5	6·8	5·5	Very acid and pleasant.	Whitish yellow, fibrous.	212	23·5 gms. 7×3·5×2·2	Green with reddish yellow flush, left shoulder high, beak present.	70
Gomantaki (Menavali).	6·5	6·3	5·7	Heavy and pungent.	Deep orange, pulpy.	166	Lost ..	Green with reddish yellow fluh, glands prominent, left shoulder slightly higher, almost no beak.	66
Dadhamio (Navsari) ..	12	10	8·5	Slightly turpentiny.	Very pale yellow, slightly reddened, tough, fibre moderate.	446	11×5×4	Greenish brown, left shoulder higher than the right, beak inverted and scarcely perceptible.	67
Shendadya (Nandgaon)	9	7	5·8	Turpentiny but pleasant.	Pale red, fibrous..	358	Lost ..	Green to yellow with black glands, left shoulder high, beak present.	68
Khobarya (big) (Menavali).	6·2	5·5	4·5	Slightly turpentiny.	Yellow to orange ; pulpy.	204	30·5 gms. 4·7×2·5×1·9	Green with orange flush on shoulder, glands fairly prominent, left shoulder high. beak slight.	71
Gopto (Navsari) ..	11	9·5	9	Unique, delicious and slightly piquant.	Pale yellow, fibre moderate, not tough.	528	9×4·5×3·5	Greenish yellow, red on the exposed side, glands prominent only on the red portion but not close, beak present but inverted.	72
Romanio (Navsari) ..	10·5	8	6·5	Luscious and heavy.	Orange, fibre small.	298	9×4×2·5	Yellow to red, glands present, left shoulder higher than the right, beak very slight.	73
Battasya (Menavali) ..	7·0	7·0	4·7	Pungent but pleasant.	Whitish yellow, slightly fibrous.	192	32 5 gms. 4·8×2·9×1·7	Yellow with rosy red on shoulder, glands not conspicuous, left shoulder high, no beak perceptible.	74

Name.	Length in c.m.	Breadth in c.m.	Thickness in c.m.	Taste.	Flesh.	Weight in grammes.	Stone.	General appearance.	Shape.
Kala-khoont (Menavali).	6·8	5·5	5·3	Piquant and delicious, slightly turpentiny.	Pale yellow, slightly fibrous.	160	26.5 gms. 6·0×4·5×3·2	Greenish yellow with yellow flush, glands not prominent, left shoulder high, no besk.	Figs. 78
Kshira-sindhu (Khed-Shivapur).	6·5	5·5	5	Acid taste, pleasant.	Orange red, juicy, slightly fibrous.	161	23 gms. 6×3·5×2·8	Yellow to brick red, glands white wide apart, smooth, left shoulder higher than right, beak slight and 2·5 c.m. from apex, apex rounded.	75
Kaju (Nandgaon) ..	9	6	5·2	Sweet and delicious.	Pale red, fibrous..	334	40 gms. 10×4×3	Green to dirty yellow, glands white or black, wide smooth, left shoulder higher than right, beak coarse and blunt, 3 c.m. from obtuse apex, basal cavity deep, fruit marked by a long line of furrow from the stalked end to the beak.	76
Walkya (Menavali) ..	11	8·2	7	Heavy but pleasant.	Pale reddish yellow.	404	45·5 gms. 9·5×4·8×2·5	Brownish green, glands prominent, left shoulder higher than right, beak slight.	77
Belya (Menavali) ..	9·0	6·5	5·5	Sweet, not pungent, no turpentine.	Canary yellow. fibrous.	160	26·5 gms. 5·8×3×1·5	Canary yellow, glands prominent, left shoulder slightly higher, beak noticeable.	82

Manoher (Khed-Shivapur).	8·5	5	4·5	Piquant ..	Yellow to red, very slightly fibrous.	188	7×3·5×3	Yellow to green with yellow glands, left shoulder high, beak present.	80
Kurhadya (Nandgaon).	10	7	6	Slightly turpentiny but sweet.	Yellowish white, juicy, very fibrous.	385	64 gms. 8·5×4·5×4	Canary yellow all over, glands black, small close and slightly rough, both shoulders falling equally, beak well marked, 3 c.m. from apex, apex rounded. basal cavity present.	81
Balimav (Dharwar) ..	11·7	6·9	6·0	Delicious, not pungent, taste like alphonse but not so heavy.		297	28 gms. 7·4×3·6×2·2	Orange, glands fairly prominent, shoulders equal, beak slight.	79
Shepya (Menavali) ..	5·4	4·5	4·0	Pungent and pleasant.	Orange ..	139	21·5 gms. 4·5 ×2·5×1·8	Pale green with yellow flush, glands not conspicuous, shoulders, unequal, slight beak, basal cavity distinct.	83
Cluster (Empress Gardens, Poona).	8·5	5	4	Sweet ..	Pale red, juicy, fibrous.	128	7×3·5×2·5	Pale yellow, thin skin, fruit small.	89
Kharbuja (Menavali)..	8·5	6·6	6·0	Sweet and pleasant	Reddish orange, fibrous.	256	31 gms. 7·2×3·7×2·2	Green with yellow flush, shoulders equal, slight beak.	85
Timod (Goa) ..	8·8	11·2	9·6	Sweet, free from turpentine but not luscious.	Yellowish white at the sides and reddish at the stone.	510	Lost. ..	Green, left shoulder high beak absent, a very broad fruit.	86
Nagya (Khed-Shivapur).	9·5	6	4·5	Turpentiny ..	Pale red, fibrous..	286	30 gms. 8·5×4×3	Green to deep yellow, glands white, prominent and rough, shoulders level, beak slight, coarse and inverted 2·5 c.m. from apex, apex rounded, basal cavity slight.	84

Name.	Length in c.m.	Breadth in c.m.	Thickness in c.m.	Taste.	Flesh.	Weight in grammes.	Stone.	General appearance.	Shape.
Anjirya (Khed-Shivapur).	10	7	5	Sweet and pleasant, slightly turpentiny.	Orange-red, fibrous.	275	37 gms. 8·5×4·5×3·5	Green to brick-red, glands white, wide apart and slightly rough, left shoulder higher than right, beak slight 2 c.m. from apex, apex rounded, basal cavity mamillate, a flat mango.	[Figs 87
Maldej (Pokal) (Goa)	10·7	6	5·2	Sweet, distinct and agreeable.	Orange-red, slightly fibrous.	256	8·2×4·5×3	Greenish yellow tinged with bright red on exposed shoulder, left shoulder very high, very slightly inverted beak.	88

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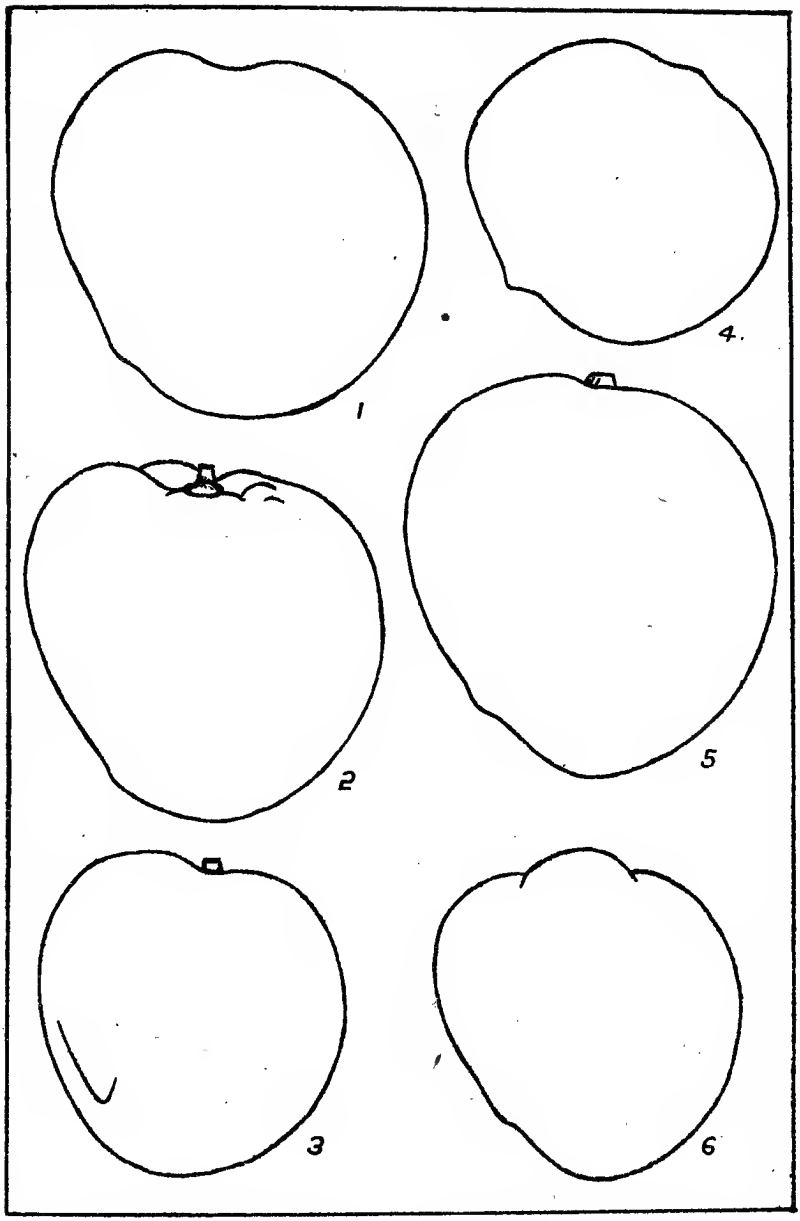
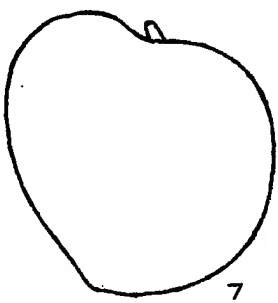


1. *Roos.* (*Navsari.*)
2. *Dilpasant.* (*Nandgaon.*)
3. *Bishop.* (*Goa.*)
4. *Dilder.*
5. *Karemav.* (*Dharwar.*)
6. *Gaddhemar.* (*Navsari.*)



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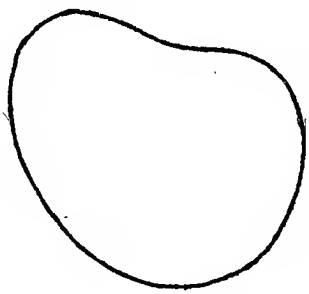

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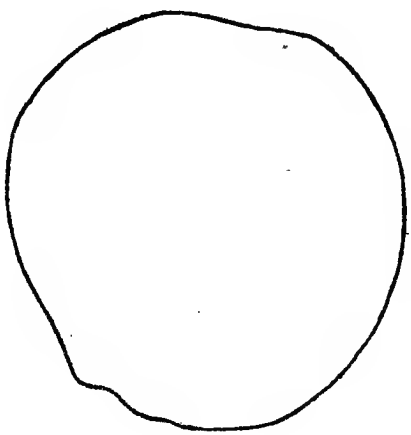
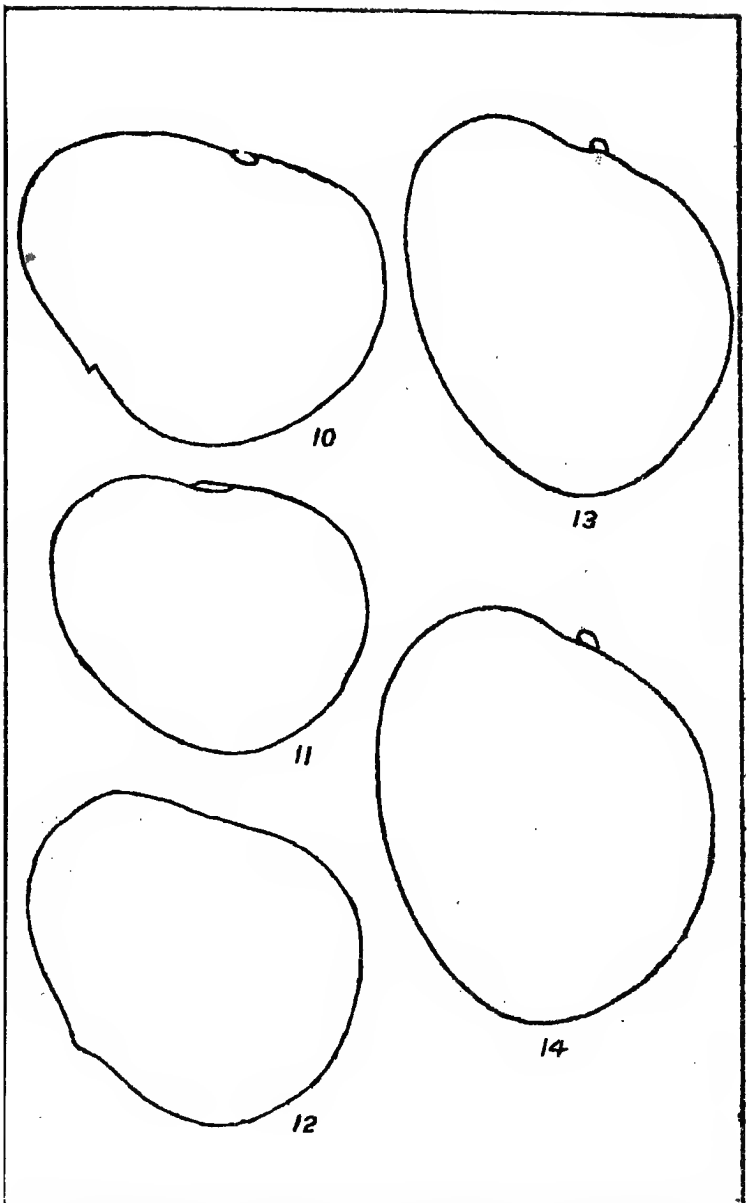
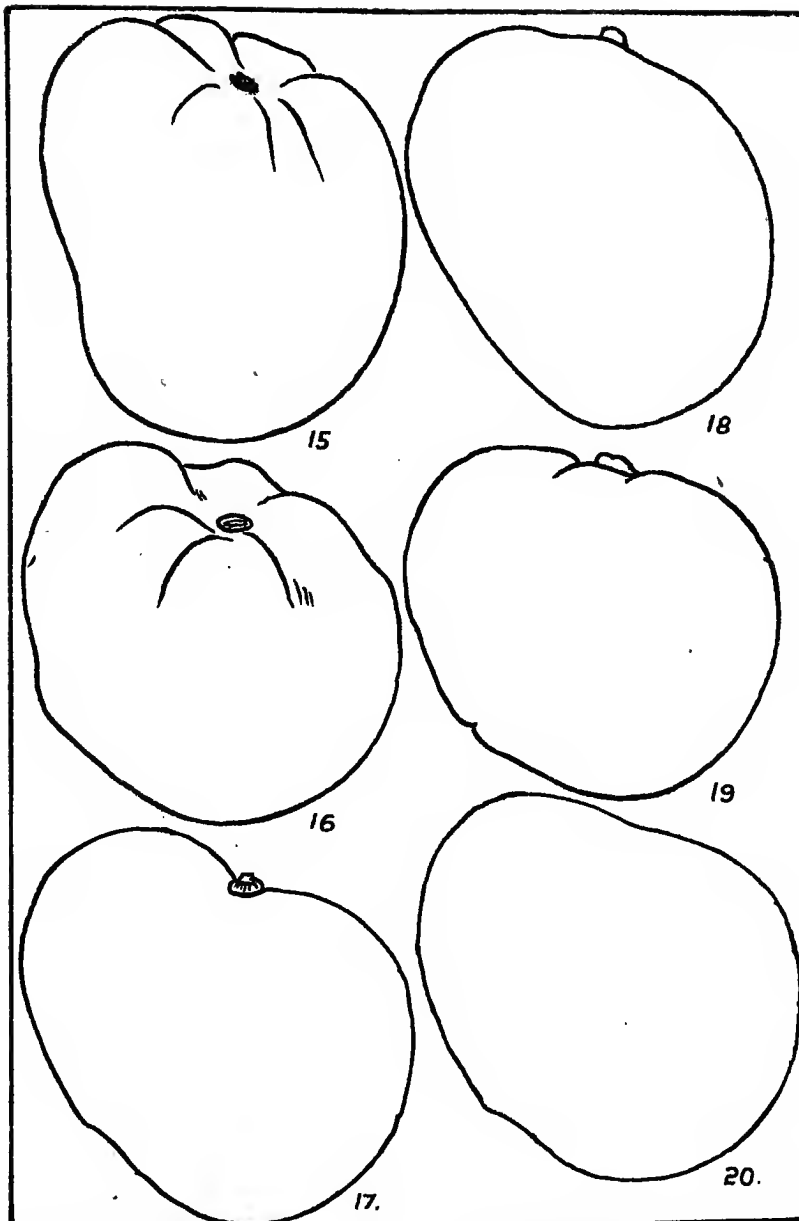


9

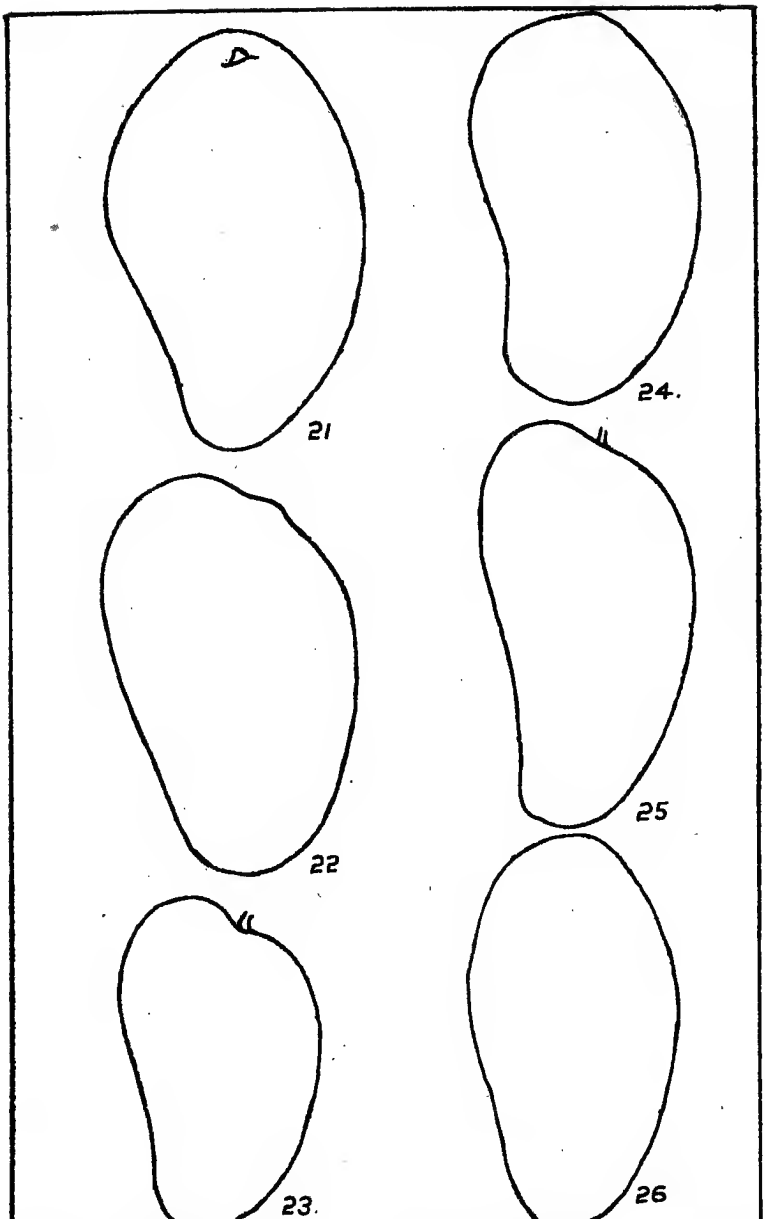
7. Rawanya. (Menavali.) 8. Gendya (Menavali.)
9. Dilhouse. (Menavali.)



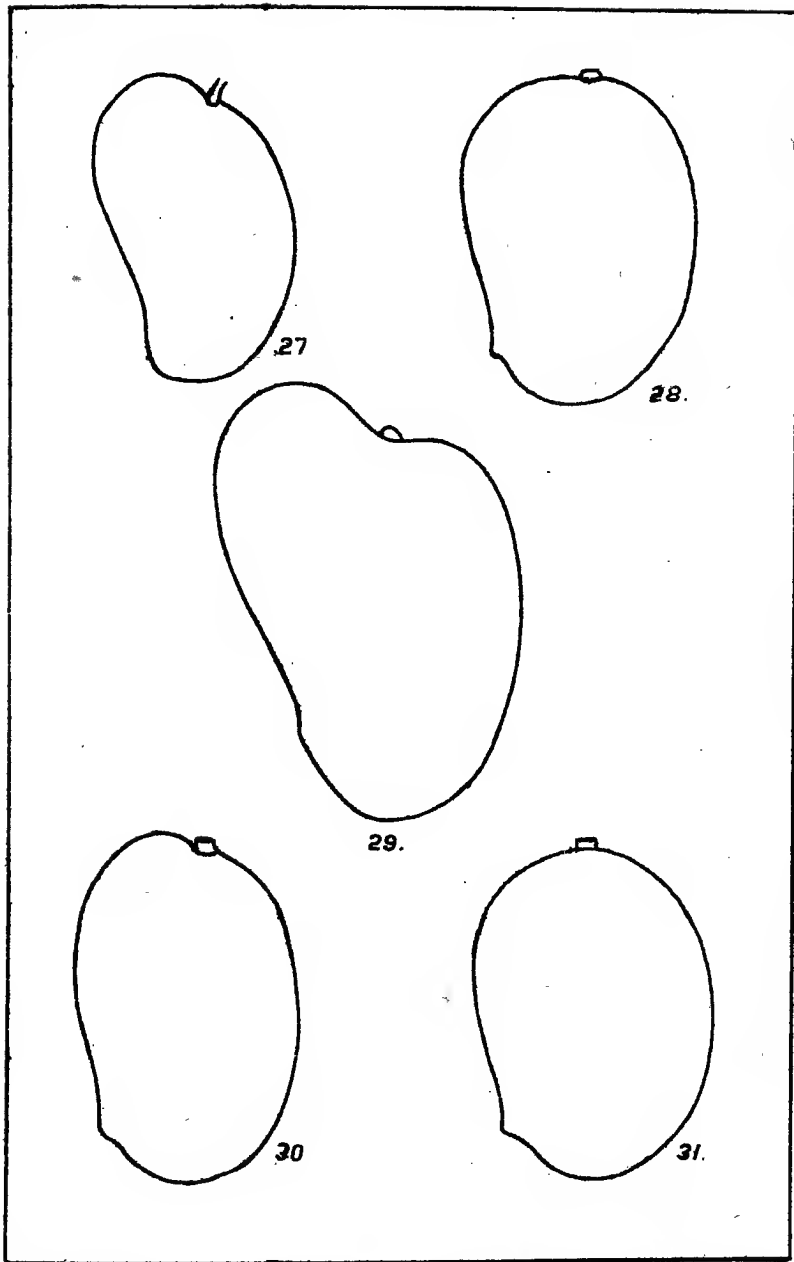
10. *Ramphalya. (Menavali.)* 12. *Fulambry. (Menavali.)*
11. *Sukhar-Gooty.(Menavali.)* 13. *Cheep. (Menavali.)*
14. *Mogarya. (Menavali.)*



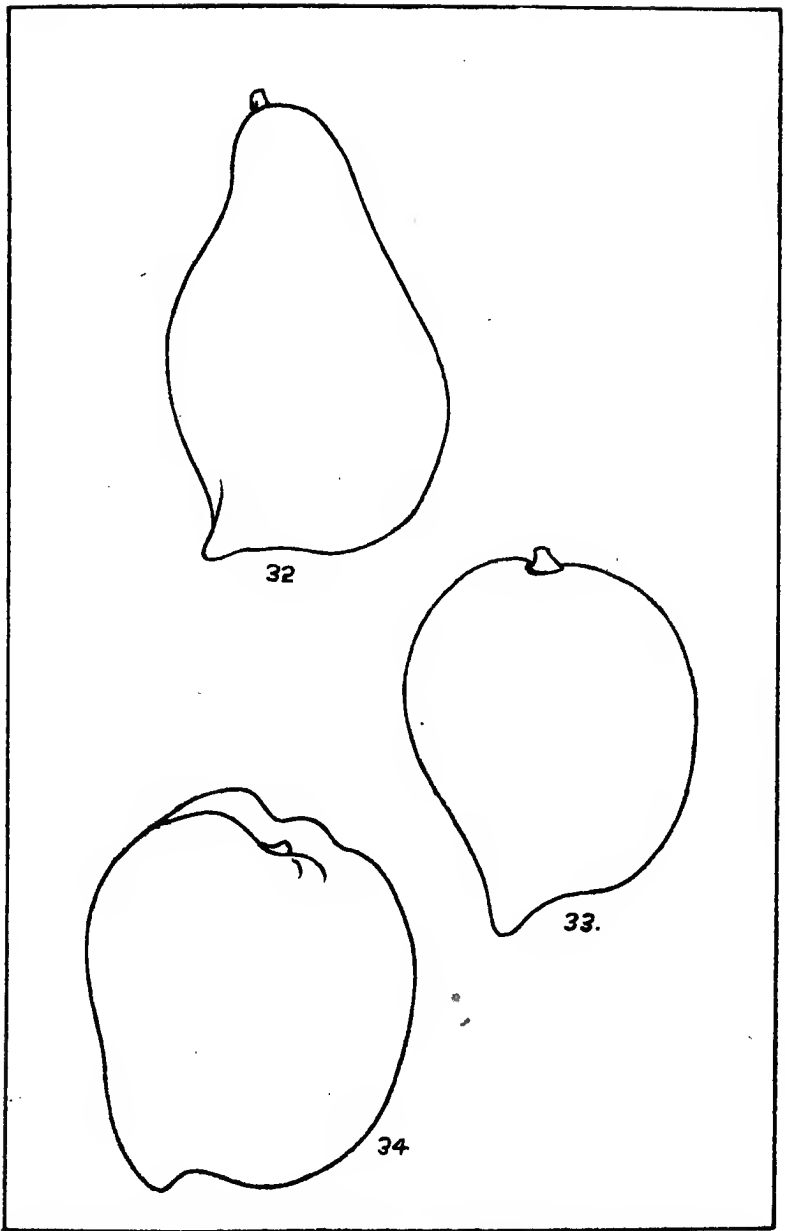
15. *Dalimbya. (Nandgaon.)*
16. *Dalimbya.(Khed-Shivapur.)*
17. *Shakar-Kand.(Thorla) (Menavali.)*
18. *Gulkand. (Menavali.)*
19. *Dilkhush. (Menavali.)*
20. *Shakar-Kand. (Dhakala.) (Menavali.)*



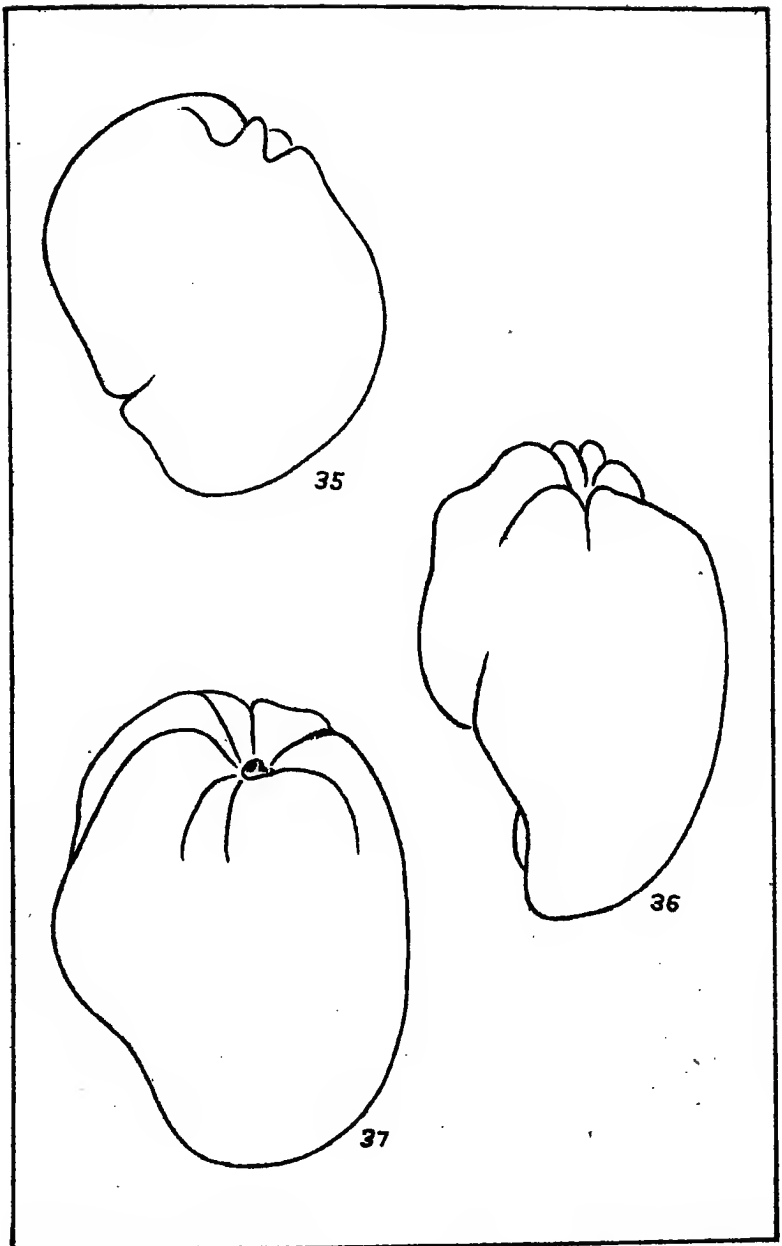
21. *Dodi. (Menavali)*
22 *Calcuttio. (Navsari.)*
23. *Kelya. (Menavali.)*
24. *Batlee. (Navsari.)*
25. *Shravan-Dodi. (Menavali)*
26. *Collace (Goa.)*



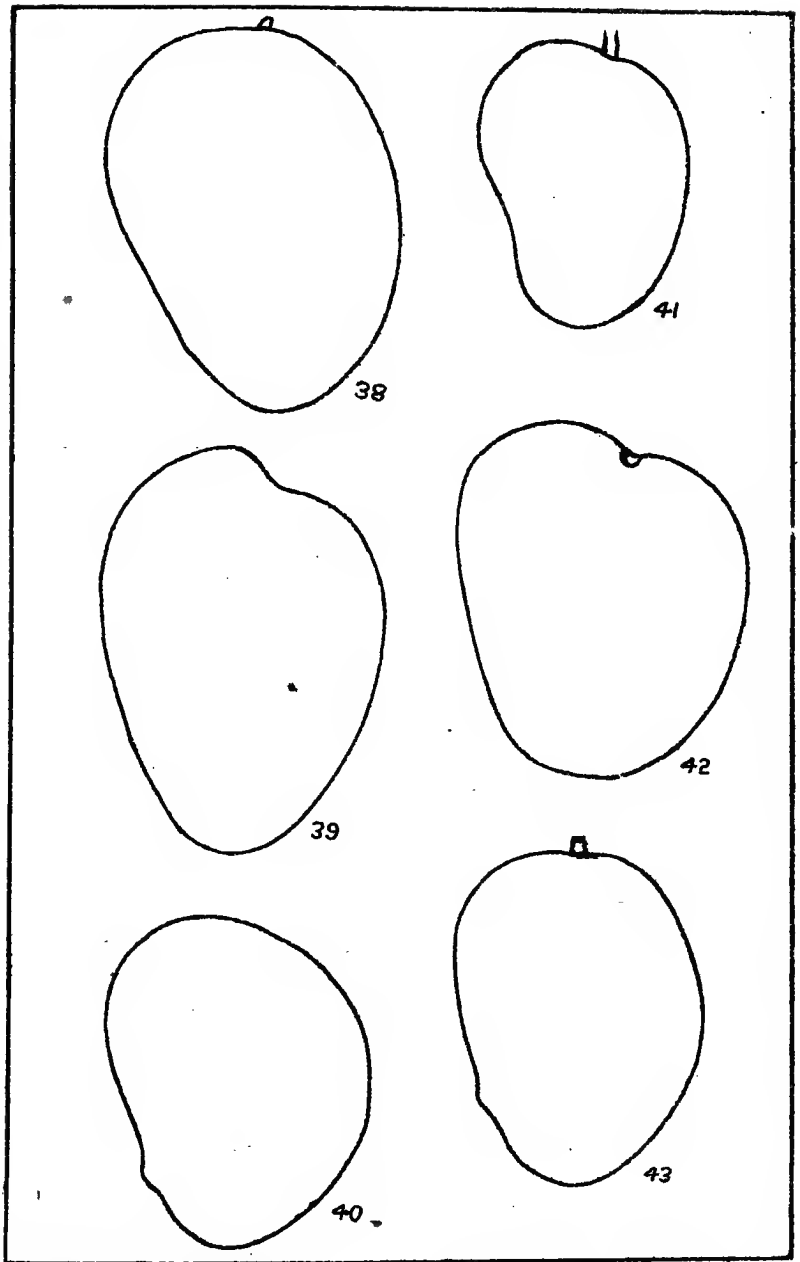
27. *Kharki*
28. *Bhungya. (Menavali.)*
29. *Kalmi. (Menavali.)*
30. *Çhatrapati.(Nandgaon.)*
31. *Ghadyali. (Menavali.)*



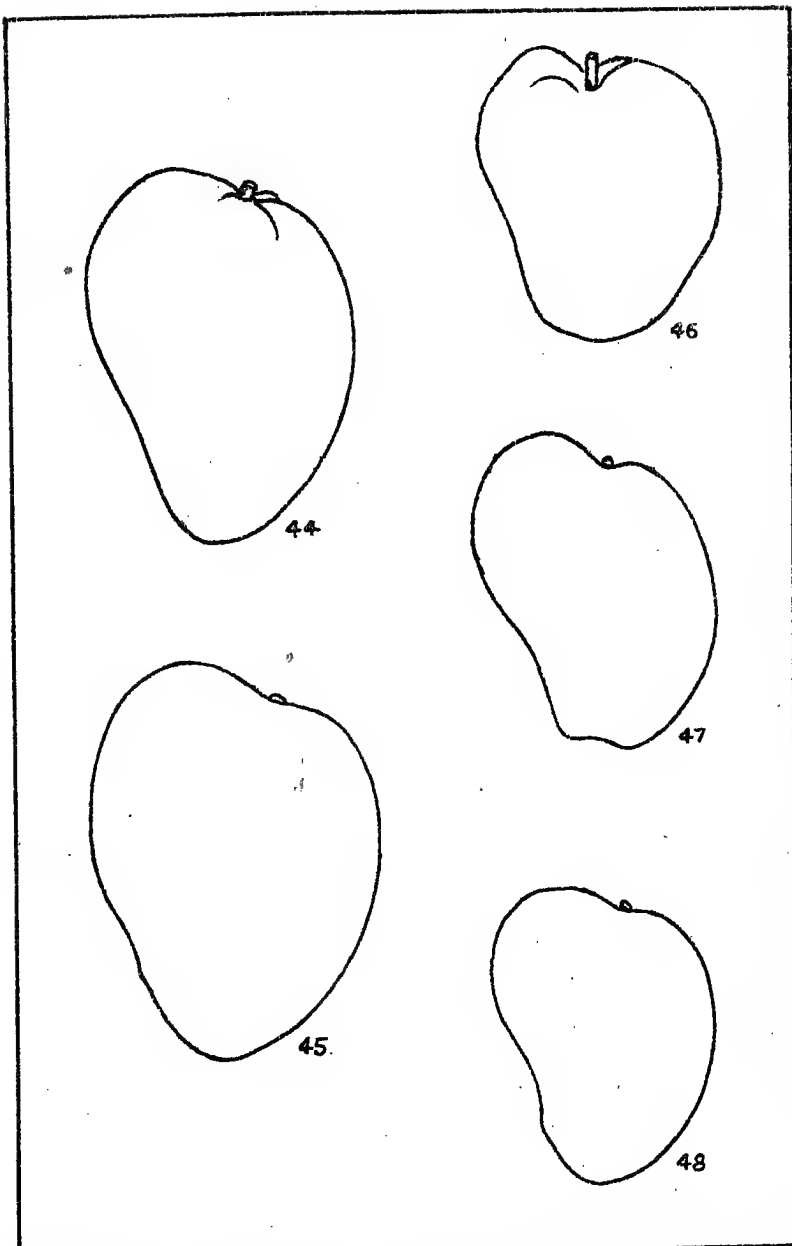
32. Popatia. (Navsari.) 33. Modya. (Menavali.)
34. Soundadya. (Nandgaon.)



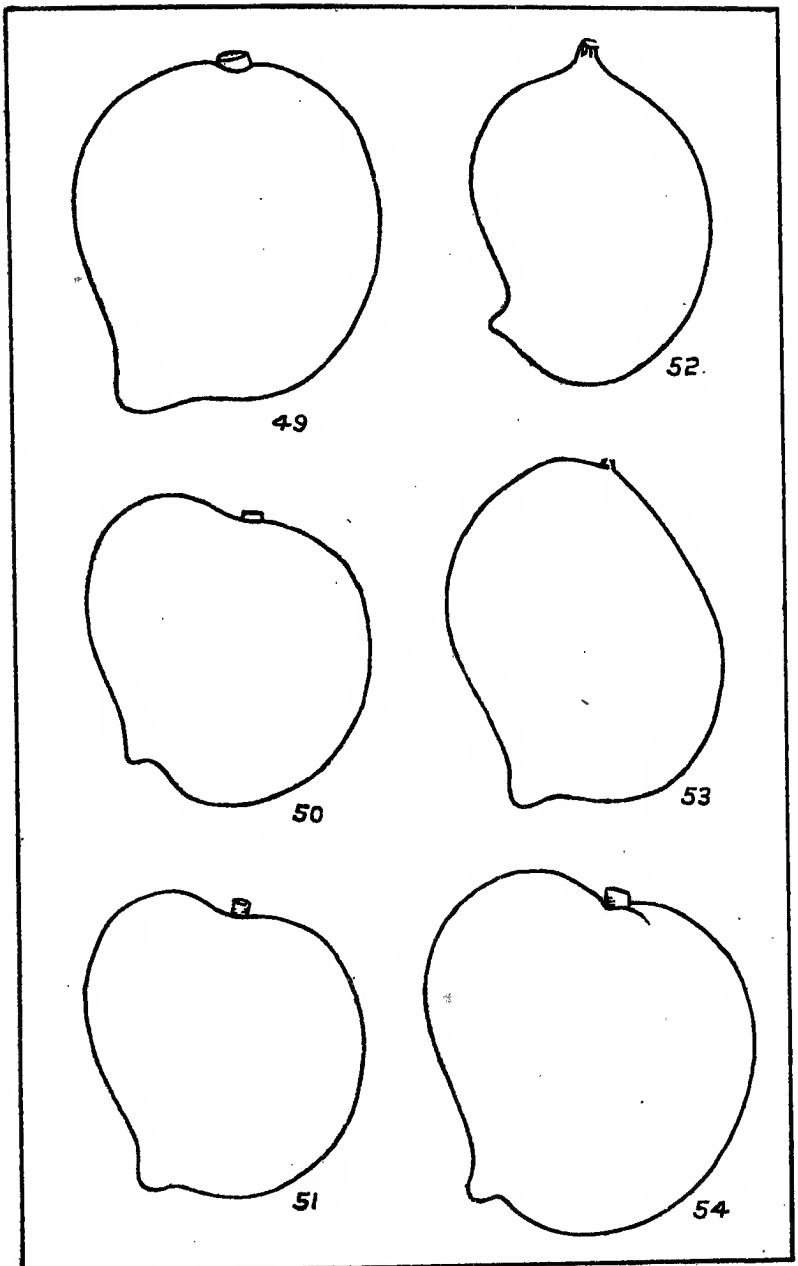
35. Karel. (Goa.) 36. Cowasji Patel. (Kirkee.)
37. Godhadya. (Nandgaon.)



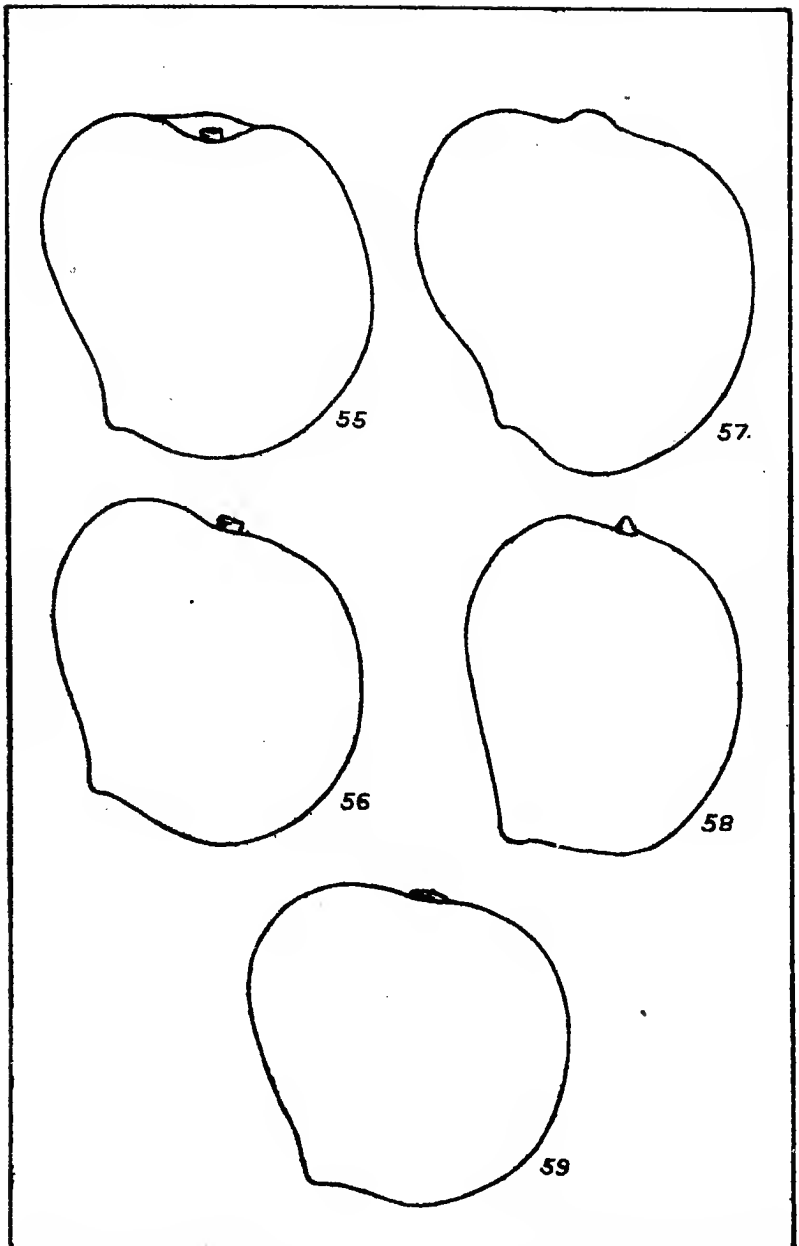
38. *Alphonse (Kirkee.)*
39. *Fernandin (Goa.)*
40. *Musherad (Goa.)*
41. *Ilar. (Goa.)*
42. *Goa-Alphonse.(Goa.)*
43. *Mankurad. (Goa.)*



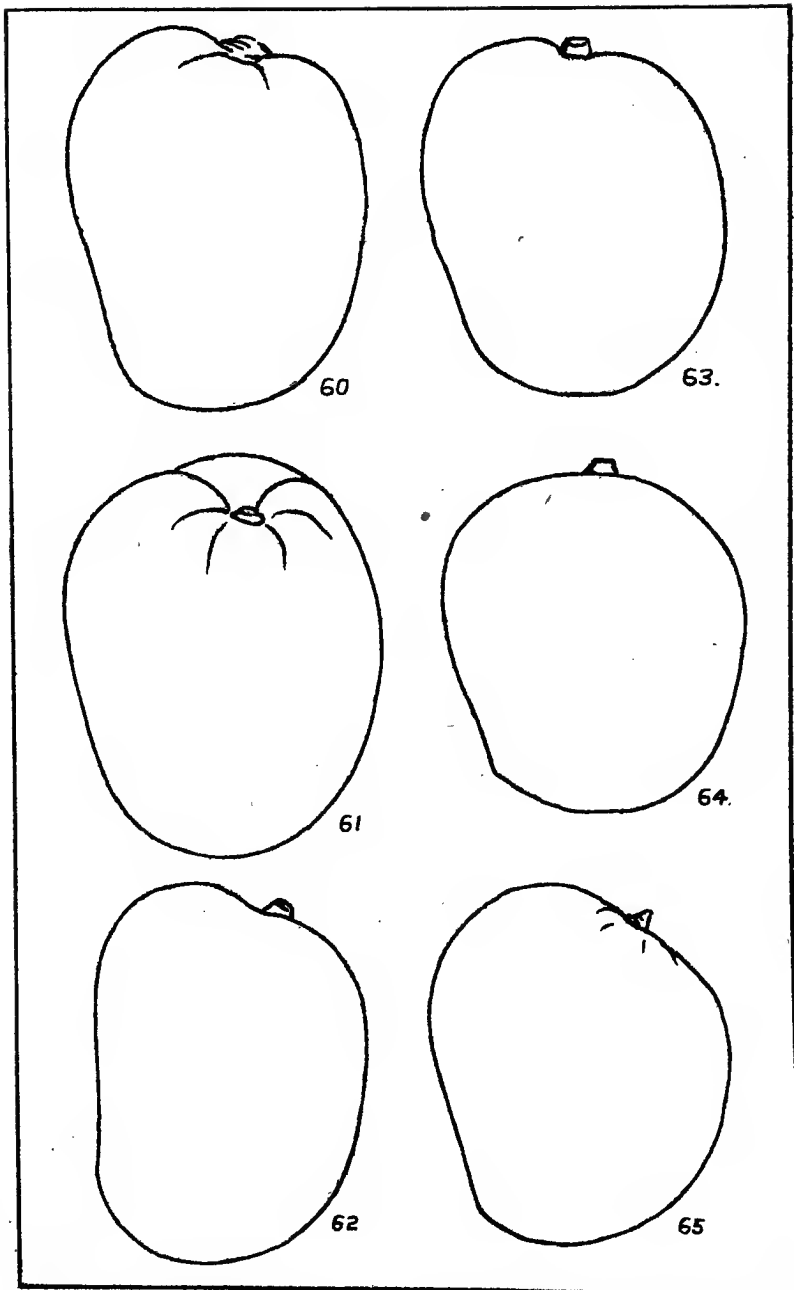
44. Katarya. (Nandgaon.) 46. Musherad- (Safet.) Goa.
45. Madan-Ban. (Nandgaon.) 47. Rabel. (Goa.)
48. Jamb. (Manavali.)



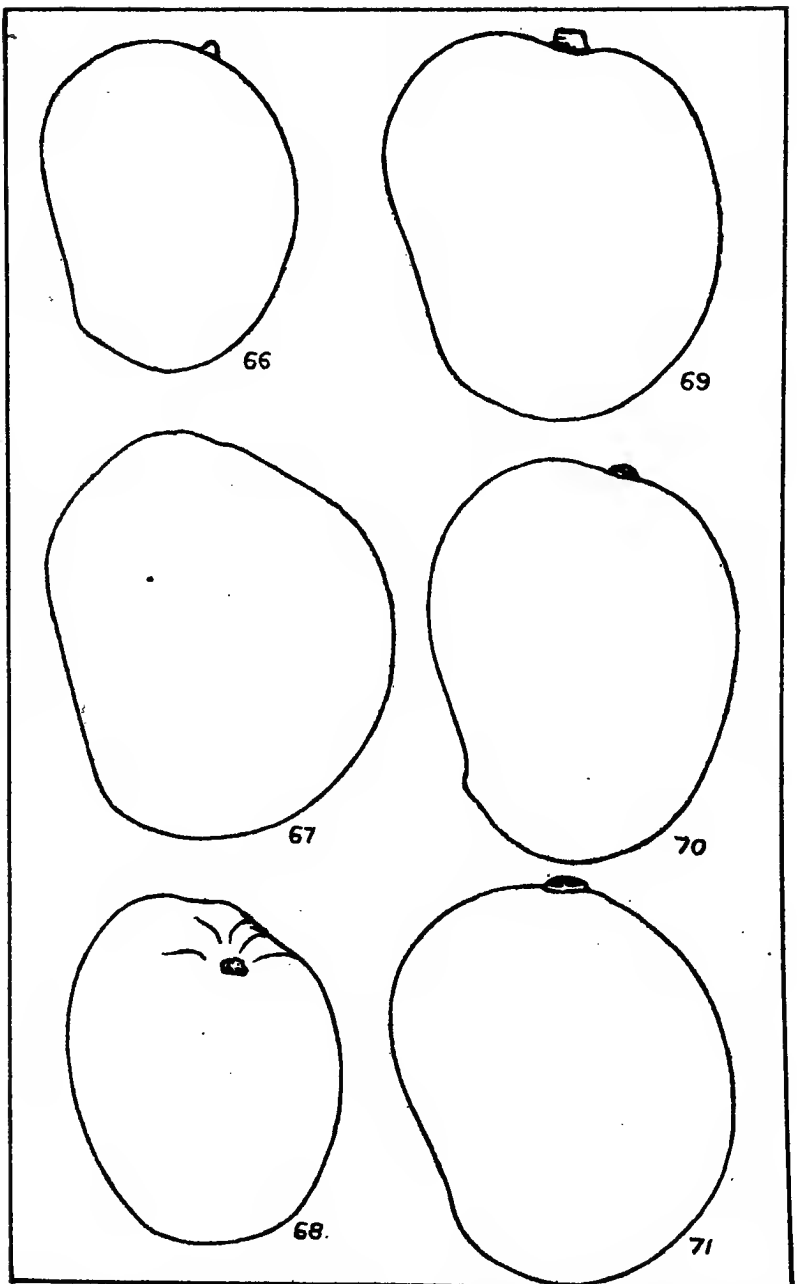
49. *Pairi.* (*Kirkee.*)
50. *Khobarya.* (*Menavali.*)
51. *Sundrya.* (*Menavali.*)
52. *Masana.* (*Navsari.*)
53. *Makhanio.* (*Navsari.*)
54. *Kelya.* (*Boparcli.*)



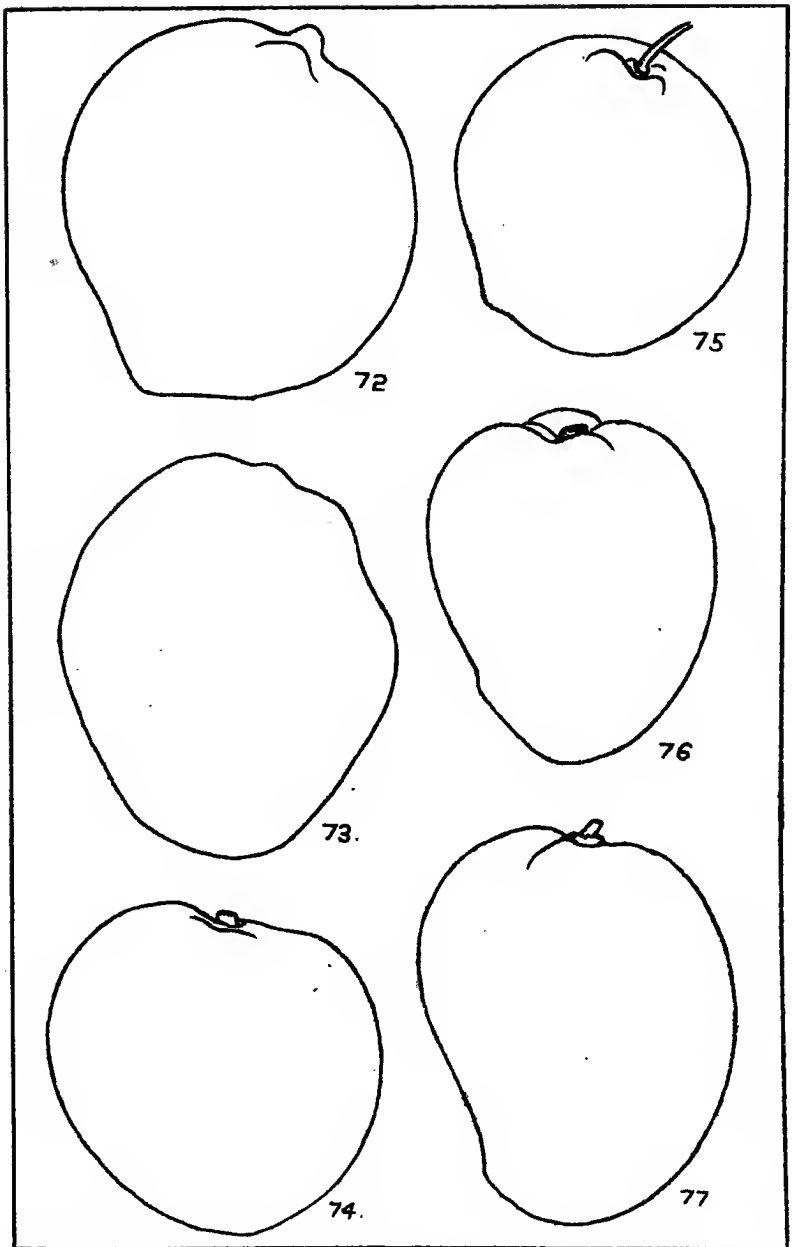
55. *Badashaha (Nandgaon.)*
56. *Surki (Menavali.)*
57. *Damdasha (Surat.)*
58. *Birbal. (Nandgaon.)*
59. *Matetin. (Goa.)*



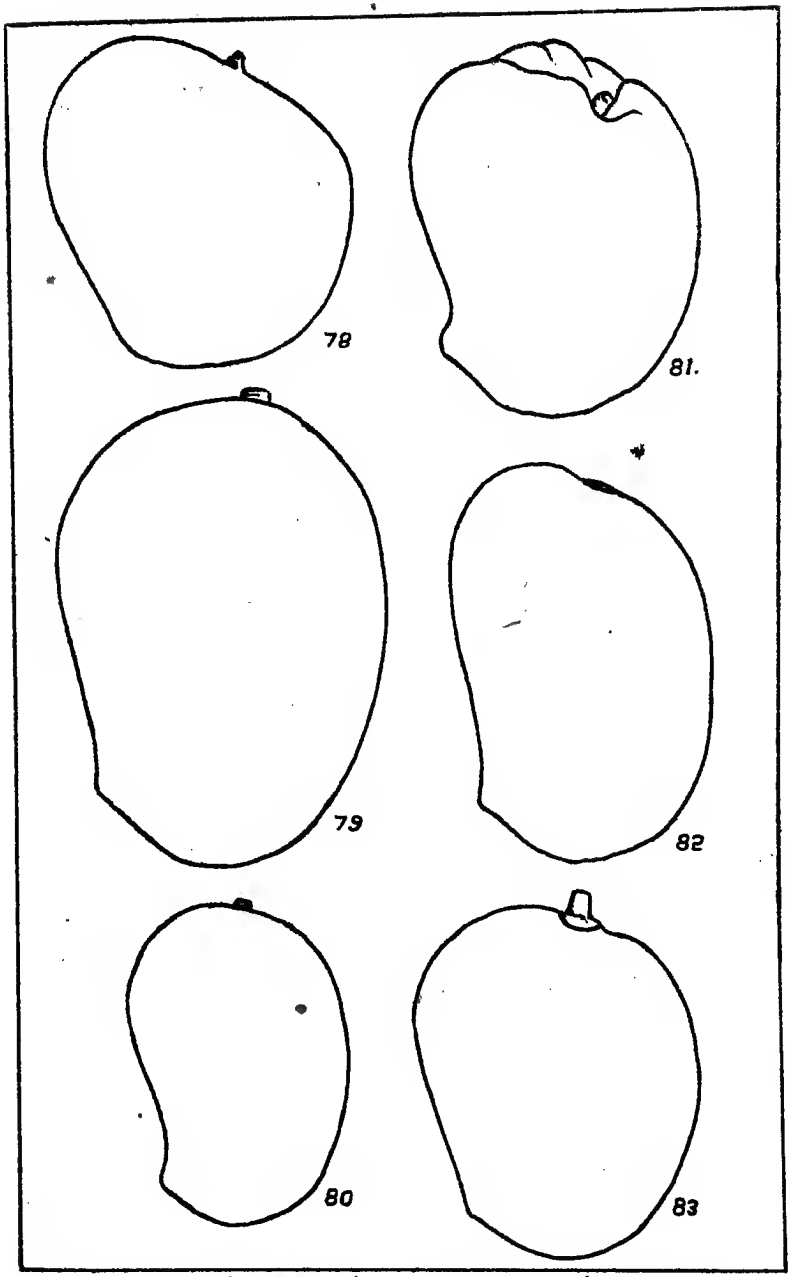
60. *Kalya. (Nandgaon.)*
61. *Dattapuri (Nandgaon.)*
62. *Maharani (Nandgaon.)*
63. *Pandharpurya (Menavali.)*
64. *Bhurya. (Menavali.)*
65. *Sanna-Yeli-Mav.*



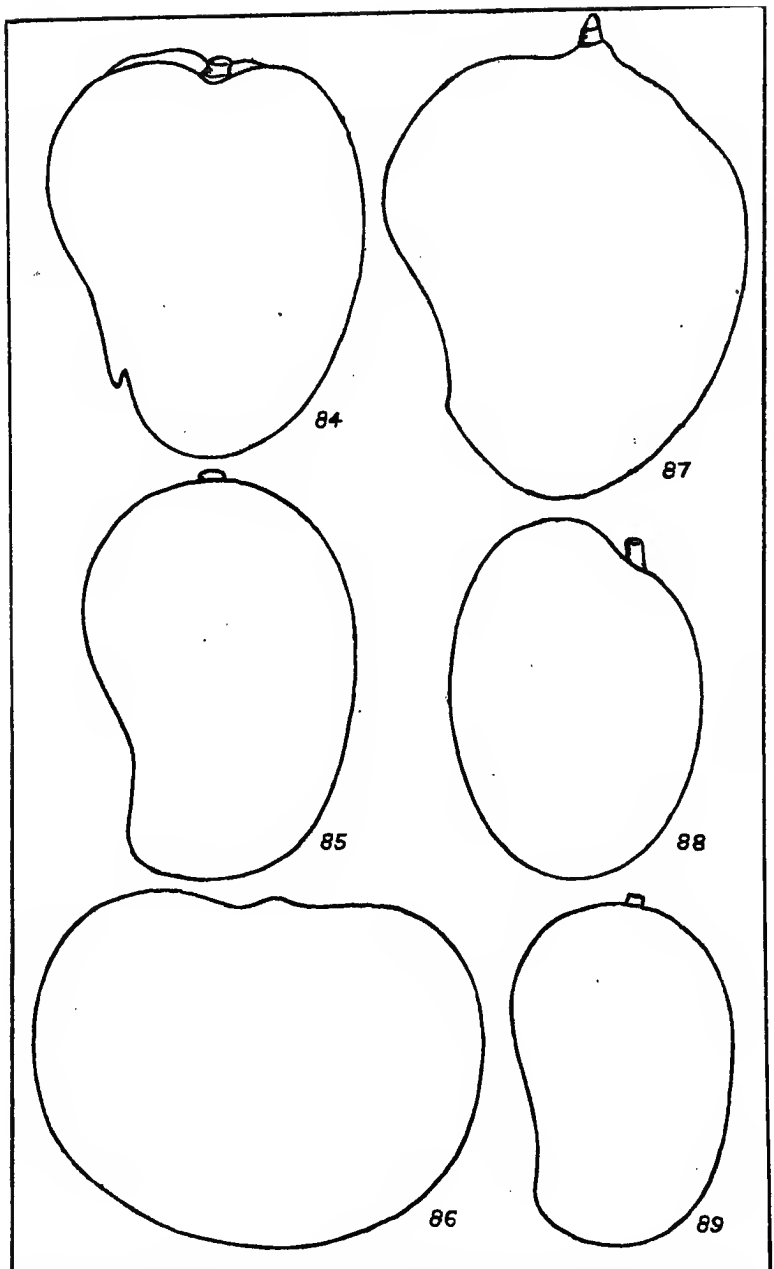
66. *Gomantaki.* (*Menavali.*)
67. *Dadhamio* (*Navsari.*)
68. *Shendadya.* (*Nandgaon.*)
69. *Gadgi.* (*Poona.*)
70. *Kelya* Nº 2. (*Menavali.*)
71. *Khobarya big* (*Menavali.*)



72. Gopto. (Navsari.)
73. Romanio. (Navsari.)
74. Battasya. (Nenavali.)
75. Kshira-Sindhu. (Khed-Shivapur
76. Kaju. (Nandgaon.)
77. Walkya. (Menavali.)



78. *Kala-Khoont (Menavali.)*
79. *Bali Mâv. (Dharwar)*
80. *Manohar. (Khed-Shivapur.)*
81. *Kurhadya (Nandgaon.)*
82. *Belya. (Menavali.)*
83. *Shepya. (Menavali.)*



84. *Nagya. (Khed-Shivapur.)*
85. *Kharbuja. (Menavali.)*
86. *Timod. (Goa.)*
87. *Anjirya (Khed-Shivapur.)*
88. *Maldez. (Goa.)*
89. *Cluster. (Empress Garden.)*